CÔTE D'IVOIRE: FISHERIES CATCH RECONSTRUCTION, 1950-2010[1]

Dyhia Belhabib and Daniel Pauly

Sea Around Us, Fisheries Centre, University of British Columbia,
2202 Main Mall, Vancouver, BC, V6T 1Z4, Canada

d.belhabib@fisheries.ubc.ca ; d.pauly@fisheries.ubc.ca

ABSTRACT

Côte d'Ivoire had a strong industrial fleet both in capacity and reach. Despite the decline of the sector the country still held a particular place within West Africa due to its harbour and shore facilities, which have made Abidjan the second most important fishing port in the region. Its industrial fleets returned to the waters of Côte d'Ivoire after West African countries declared their EEZ which, along with large foreign fleets, contributed to over-exploiting the country's EEZ. Despite all this, official data suggest catches are increasing, which raises doubts as to their reliability. Moreover, official data do not include a large part of artisanal and subsistence catches, and also omits discards and a relatively important part of the industrial catch. They include, on the other hand, the foreign catches of *'faux poissons'* from the water of neighboring countries, but labeled domestic fish when landed in Côte d'Ivoire. To estimate total catches and improve their geographical resolution, we reconstructed them by sector, considering effort, catch per effort, and geographical distribution of catches and their taxonomic identity. Total catches from Côte d'Ivoire EEZ were estimated at 7.06 million t between 1950 and 2010, which is 2.67 times the data supplied to the FAO (this accounts for 374,200 t of *'faux poissons'* in the data supplied to FAO). Domestic catches declined, in contrast to the increase suggested by official data, but the catch of foreign fleets, mostly illegal, increased. Some social consequences for Côte d'Ivoire are outlined.

INTRODUCTION

Côte d'Ivoire, with Abidjan, the capital city at 6°51'N – 5°18'W, is located in Sub-Saharan West Africa (Figure 1). The country is bordered by Liberia and Guinea from the West, Mali and Burkina Faso from the North, Ghana from the East and the Atlantic Ocean from the South, making Côte d'Ivoire one of the largest coastal countries of the Gulf of Guinea. The location of Côte d'Ivoire within the Equatorial Savanah of Africa and the Gulf of Guinea is ideal as it experiences seasonal coastal upwelling, strong river flow and discharge into the ocean (Hardman-Mountford 2000). This has contributed to the development of a coffee and cocoa based economy in the 1960s and 1970s as well as further expansion of the fisheries sector.

Côte d'Ivoire gained independence from France in 1960; it was, at the time, one of the most prosperous countries of West Africa. This prosperity increased under the rule of president Houphouët-Boigny; the French expatriate community doubled, the country became a world leader in cocoa and coffee production (third after Brazil and Columbia in coffee production), its exports flourished by 40% as its annual economic growth rate stabilized at 10% (the highest of African non-oil exporting countries).

The beginning of the economic collapse was triggered in combination of a drought that heavily impacted cocoa plantations and the world economic recession of 1980 that
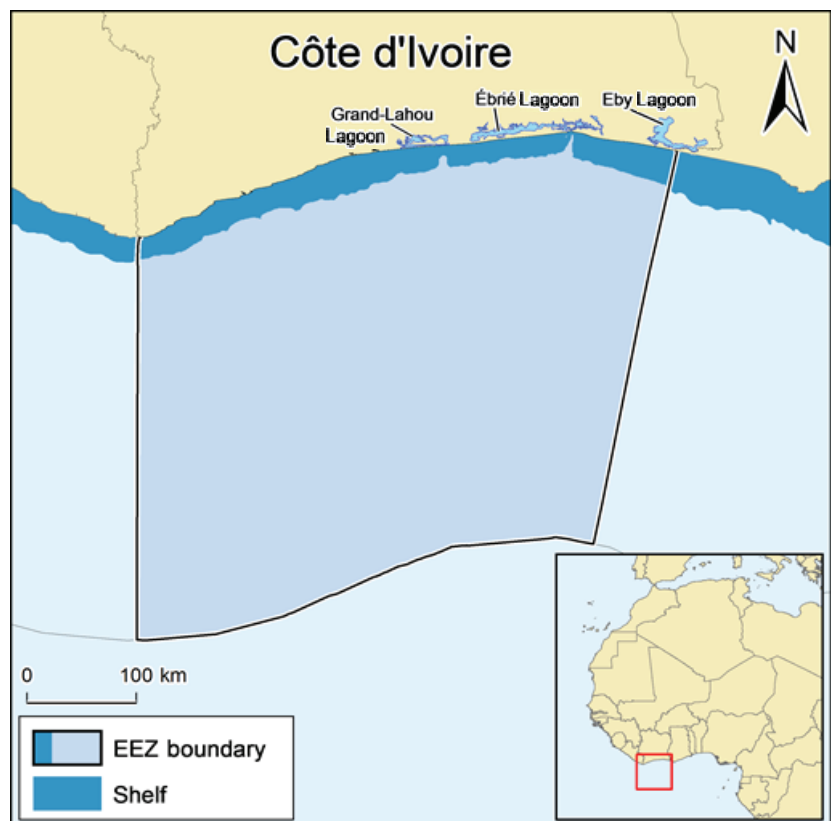

Figure 1. The Côte d'Ivoire's Exclusive Economic Zone (EEZ) and major coastal lagoons.

affected cocoa prices on the other. This led to a social crisis that began with protests in 1990. With the death of the former president who had maintained ethnic accommodation, the pseudo-nationalist concept of 'Ivoirité' was used to discriminate against the many recent (and not-so-recent) immigrants to the country, who had arrived in colonial time to work in Côte d'Ivoire (Connelly *et al.* 2013). Along with the devaluation of the currency FCFA (Akindes 1995), the prohibition of immigrant southward migrations within Côte d'Ivoire, the vulnerability of the immigrants to forceful land grabs in the south (Dabalen *et al.* 2012) and a number of incidents against Ghanaians (Kouadio 2009) were all precursors to a number of coup attempts in the 1990s (Dabalen *et al.* 2012). These regional disparity were triggers that exploded into a civil war in 2002, ending the long-lived, peaceful political and productive economic conditions in Côte d'Ivoire (Morric MacLean 2004). The situation was exacerbated during the 2000s, as violence heightened (2000 and 2004-2006), instability grew in the North, 'foreigners' were increasingly expelled, 500,000 people were internally displaced and 224,000 became refugees (Global Witness 2007). Widespread chaos was fueled by the lack of wealth and income as the number of people living under the national poverty line increased from 10% in 1985 to 45% in 2008 (Global Witness 2007; Connelly *et al.* 2013).

Such historical events, social crisis and natural disasters had a large impact on Côte d'Ivoire fisheries. For example, during the 1958 conflicts between Côte d'Ivoire and Benin, fishers were driven to migrate westwards. Also, at the end of World War II, the number of Ghanaian fishers in Côte d'Ivoire had increased tremendously (Koffie-Bikpo 2012). Similarly, military-political crises since 2002 have negatively affected fisheries (Koffie-Bikpo 2012), e.g., Ghanaians small-scale fishers being expelled from Côte d'Ivoire. After independence (1960), the number of artisanal fishers along the coast increased, due in part to the development of infrastructure, notably a coastal road (Koffie-Bikpo 2012).

Fisheries are sensitive to the conditions surrounding them and have high importance for local populations, notably to food security. As poverty increases in the country, fisheries are an alternative way of sustaining livelihood after the collapse of the cocoa and coffee economies. Local populations began to view fisheries as a major asset, which leads them, in the absence of government structures, to manage fisheries on a local scale. For example, in 1982, all foreign artisanal fishers using mainly collective gear were denied access to Ebrié Lagoon, one of the largest lagoons of Côte d'Ivoire (Koffie-Bikpo 2012), leading to an increase in the number of fishers in the neighbouring lagoons (Figure 1).

Although these kind of initiatives are common in Côte d'Ivoire, the overexploited state of fisheries, as reported since the 1970s (Cormier 1983; Garcia and Poinsard 1989), raises questions regarding the management of fisheries and the reliability of reported data, particularly during this period of instability. Officially, there are two main sectors in Côte d'Ivoire, artisanal and industrial. The artisanal sector, operating canoes and pirogues, is difficult to assess given the disparity of landing sites, the consumption of a portion of the catches by fishers and their families and the variability of fishing techniques (Cormier 1983). Although field surveys started in 1978, they only included a part of the canoes and pirogues along the coast, and they omitted land-based fishing, resulting in all individual fishing techniques excluded from official reports (Ecoutin 1992). Furthermore, no artisanal fishery data have been collected in recent years and most data failed to reach FAO since 1990 (FAO 2008; 2009). On the other hand, the industrial fishery, which includes trawlers, small-pelagic seiners and tuna purse-seiners "is monitored at the Abidjan fishing port, every day. The entry and exit data of vessels and fish sales slips are collected every two weeks by the research team from the Oceanographic Research Centre (CRO) to estimate the effort and catch per species" (FAO 2009). The foreign industrial fishery of Côte d'Ivoire, however, still remains difficult to assess given their geographical and gear disparity, and few reliable data are made available through logbooks (EU 2008).

Given the importance of fisheries for the livelihood and food security of Ivoirians, and the current over-exploitation status of its marine fisheries resources, there is a serious need to address the lack of fisheries catch data in Côte d'Ivoire and analyze the impact of the different fisheries sectors.

METHODS

Coastal population

Total population was obtained through the WorldBank database (data.worldbank.org [2014]) covering the period between 1960 and 2010 and from Populstat database (www.populstat.com [2014]) for 1950. These data were interpolated to obtain the total population of Côte d'Ivoire between 1950 and 2010. CIESIN (2012) provides coastal rural population estimates (here: rural population living within 10 km from the coast) for 1990, 2000 and 2010. This allowed for the estimation of the coastal population percentage over the total population for Côte d'Ivoire. This was found to be at 1.5% for 1990, 1.9% for 2000 and 2.1% for 2010, which suggest migrations towards the coast, notably to escape conflicts. We assumed this rate was constant between 1950 and 1990 and interpolated linearly to fill in the gaps (Figure 2).
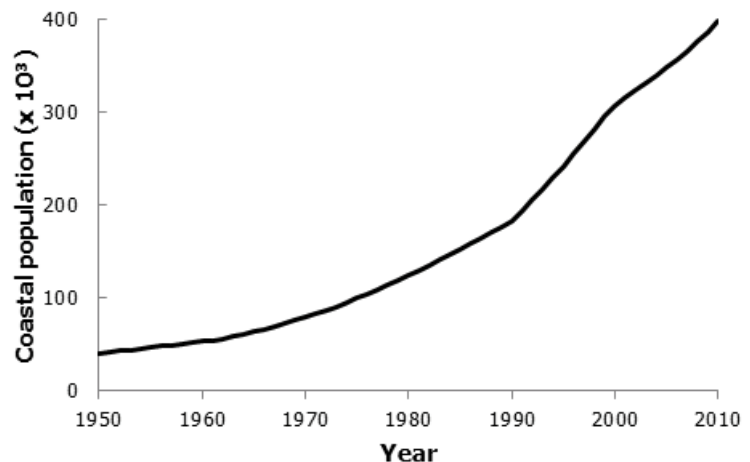

Figure 2. Coastal population in Côte d'Ivoire , 1950-2010.

Artisanal fisheries

Artisanal catches were mainly lagoon-based prior to 1960. After independence in 1960, the number of artisanal fishers along the coast increased due in part to the development of infrastructures, notably a coastal road (Koffie-Bikpo 2012) along with the opening of the Ebrié Lagoon and the industrialization of lagoon-based subsistence fisheries, which translated into the expansion of fishing grounds to the maritime coast of Côte d'Ivoire. In 1982, foreign artisanal fishers were denied access to Ebrié Lagoon and collective gears, e.g. beach seines, prohibited, which increased the number of foreign fishers in neighboring lagoons (Koffie-Bikpo 2012). Later on, artisanal fishing practiced initially by a few ethnic groups, e.g. Alladians, Keta, Apollonians, but mostly Fanti from Ghana (Delaunay 1992), was heavily impacted by socio-political conditions. For example, the number of Alladian fishers had declined from 1,100 in 1950 (Ecoutin 1992) to 18 in 2010 (Koffie-Bikpo 2012). Conflicts drove Ghanaian fishers to return to Ghana, and the number of Ghanaians in Côte d'Ivoire declined by 20% between 1988 and 1998 (Badmus 2009). Ghanaians had dominated the fishing industry previously(Kouadio 2009), so their departure significantly reduced the number of fishing vessels, similar to the situation in Liberia as a result of the civil war (Belhabib *et al.* 2013). These fishers, who initially migrated to Côte d'Ivoire because of a crisis in Nigeria and Ghana in the 1970s and 1980s, constituted around 17% of the coastal population of Côte d'Ivoire (Kouadio 2009). Understanding these dynamics and the historical evolution of artisanal fisheries is an important preliminary step to the reconstruction of catches, as it allows for critical evaluation (whether to accept or reject) of the estimates by literature, which appear to be either unreliable, under-estimated or obtained via ad hoc meetings (FAO 1981; FAO 1985, 2008a, 2009). Furthermore, artisanal catch and effort data reported by literature often do not reflect socio-demographic changes alluded above, e.g. the decline of lagoon catches by artisanal fishers in the 1970s, due to the development of industrial fisheries and the departure of Ghanaian (Koffie-Bikpo 2012), does not show in official data. Indeed, it is not even always clear whether these data include lagoon and freshwater catches. For instance, artisanal catches are marked as "unknown" in official reports of the CECAF Working Group between 1963 and 1975 and for 1979 for *Sardinella aurita*, and are unrealistically low between 1976 and 1978 (FAO 1981); this situation re-appears even after 1981 (Cury and Roy 1987).

Landing data were available for the 1980s and 1990s, when the CRO was at its peak activity, and collaborating with the French Institute of Research for Development (IRD); some data from the 2000s are also available. We reconstructed artisanal marine catches based on the number of artisanal boats along with the average catch per unit of effort (CPUE), and we interpolated between the available numbers of artisanal boats, which we used as anchor points (Table 1). We estimated CPUEs based on the catch

Table 1. Number of artisanal marine pirogues between 1950 and 2010 in Côte d'Ivoire.

Year	Boats	Source
1950	1,095	Postel (1950); Cormier (1983);
1956	1,000	Lassarat (1958);
1964	1,438	2,650 pirogues (Domingo 1980) of which 54% are marine (Gerlotto and Stequert 1978; Cormier 1983);
1969	1,500	Gerlotto and Stequert (1978); Cormier (1983);
1975	1,574	Total number of artisanal boats averaged between 3,000 and 2,800 (Cormier 1983; Collari 1986) of which 54% were marine (Gerlotto and Stequert 1978);
1979	1,638	Over 3,018 artisanal boats (Domingo 1980), 54% of which were marine (Gerlotto and Stequert 1978);
1996	1,618	A total of 3,326 artisanal boats (Kébé *et al.* 1997) of which 48% were active marine boats (Shep *et al.* 2011; Pérez-Ruzafa and Marcos 2012);
1999	1,860	We assumed an increase of 15% of the effort because of increased migrations towards the coast from the lagoons because of political events (new elections and violence);
2010	1,372	Shep *et al.* (2011)

estimate by Ecoutin (1992), i.e., 35,000 t for 1984, divided by the interpolated number of artisanal marine boats (1,632 boats), i.e., 21.4 t·boat^{-1}·year^{-1}. Considering over-exploitation (Cormier 1983; Garcia and Poinsard 1989) and the increasing capacity of artisanal fishing boats, we assumed the CPUE was 15% higher in 1950 and 15% lower in 2010. We interpolated between the CPUE estimates, then multiplied the latter by the effort to estimated artisanal marine catches between 1950 and 2010.

Lagoon catches

There are three main lagoons in Côte d'Ivoire: Ebrié Lagoon, Aby Lagoon and Grand-Lahou Lagoon. In these lagoons, only collective fisheries are monitored, i.e., cast nets, traps and lines are not included in official statistics, the individual gear being more appropriate for subsistence purposes, and/or yielding a catch sold directly to restaurants (N'Goran 1990). Prior to 1975, lagoon catches were not taken into consideration in official statistics (Kébé *et al.* 1997). Post-1979, only partial catch and effort data are taken into consideration. If partial effort was examined then partial geographic areas and partial catches were assessed (Doucet *et al.* 1985).

Total lagoon landings were reported between 1994 and 1996 (Kébé *et al.* 1997) and were herein considered reliable. We estimated total lagoon catches for 2010 by multiplying the CPUE of 3,744 kg·fisher^{-1}·year^{-1} by the total number of fishers (2,898) provided by Pérez-Ruzafa and Marcos (2012) for 2010. To complete the time series, we estimated lagoon catches separately for the three lagoons mentioned above between 1950 and 1985 for Ebrié and Grand-Lahou Lagoons, 1950 and 1998 for Aby Lagoon, the sum of which represents the annual artisanal lagoon catch.

Landings for Ebrié Lagoon were estimated by Cormier (1983) and Ecoutin (1992) between 1975 and 1985 and were considered reliable. The number of fishers using collective gear in Ebrié Lagoon was estimated at 5,300 fishers for 1974 (Ecoutin 1992). Thus, we estimated the number of fishers for 1950 by adjusting the estimate to account

for changes in coastal population, i.e., we multiplied the number of fishers for 1974 by the rate of change in the coastal population between 1950 and 1975 (Figure 2). We then multiplied the number of fishers by the CPUE of 3,744 kg·fisher^{-1}·year^{-1} (Pérez-Ruzafa and Marcos 2012). This CPUE was kept constant between 1950 and 2010, assuming that villages adjusted for overexploitation due to non-selective fishing gear and mesh-size (Cormier 1983) by implementing new regulations such as the prohibition of collective fishing gears, e.g., in Ebrié Lagoon (Ecoutin 1983). We interpolated to complete the Ebrié Lagoon catch time series between 1950 and 1985.

Collective fishing catches for Aby Lagoon were estimated and reported by different literature sources for the period between 1979 and 1998 (Charles-Dominique *et al.* 1980; Bayley 1988; Konan 1998), which we considered reliable. The number of fishers was estimated at 1,654 for 1967 (Cormier 1983). We estimated the number of fishers for 1950 by following the same adjustment approach described above using coastal population estimates and estimated a number of 960 fishers for 1950. We multiplied the number of fishers for 1967 and 1950 by a CPUE of 3,744 kg·fisher^{-1}·year^{-1} (Pérez-Ruzafa and Marcos 2012), and then interpolated to complete the time series between 1950 and 1998.

Similarly, catches for Grand-Lahou Lagoon were estimated at 4,140 t for 1969 (Bayley 1988) and 1,500 t for 1985 (Ecoutin 1992). To estimate collective fishing catches in Grand-Lahou Lagoon in 1950, we estimated the number of fishers using the estimate provided for 1969 of 2,995 fishers (Bayley 1988), adjusted by the coastal population, i.e., 1,593 fishers in 1950. We then multiplied the latter by the CPUE provided by Pérez-Ruzafa and Marcos (2012), and interpolated to complete the catch time series for Grand-Lahou Lagoon between 1950 and 1985.

We calculated the annual sum of collective fishing catches for the three previous areas between 1950 and 1985 and then interpolated to the first estimate of total lagoon catches for 1994 (Kébé *et al.* 1997) and then between the estimate for 1996 (Kébé *et al.* 1997).

Subsistence catches

Subsistence fishing in Côte d'Ivoire plays a major role in providing local communities with fish, as households looked for other economic alternatives, particularly after the devaluation of the FCFA (Akindes 1995). Evidence from nearby Liberia and other countries have shown that when communities struggle for food in conflict situations, subsistence activities such as hunting and fishing increases (Foster *et al.* 2009). Although small-scale fishing in Côte d'Ivoire was mainly subsistence in the past, there has been a certain degree of 'professionalization' since the early 1980s, which translated into a decline of individual fishing aimed at subsistence in villages excluded from the ban of collective fishing techniques (Verdeaux 1981). When collective fishing techniques were banned, rather than an increase in the number of individual subsistence fishers, an expansion of the fishing areas occurred (Verdeaux 1981).

There are three main types of subsistence fishing in Côte d'Ivoire considered in the present study: (i) fishers using individual gear in the lagoons, (ii) artisanal fishers taking lagoon fish home, and (iii) artisanal fishers taking sea-caught fish home. Item (iii) was restricted in the past to a few species of sparids and groupers being kept for personal consumption, while sardines, sardinellas and sharks were sold in the markets (Koffie-Bikpo 2012). Lagoon fishers use several techniques, the most wide-spread one is the *acadja* method that is called "*tegbe*" or "*niapra*" in Côte d'Ivoire (Verdeaux 1981), in reference to the hollow wood used to form enclosures used to concentrate and catch fish (Durand *et al.* 1994). Although catches taken using these methods are occasionally sold, we consider it to belong to the subsistence sector.

Cast net fishing

We estimated subsistence catches using cast nets separately for Aby and Ebrié Lagoons, and other lagoons, as the product of the catch per fisher and the number of fishers.

The number of cast net fishers in Ebrié Lagoon were assessed by Durand *et al.* (1978) at 3,375 fishers (1972 and 1973), Laë (1992) at 2,160 fishers for 1977, and by Durand *et al.* (1994) at 2,970 fishers for 1994. To obtain the number of fishers for 1950, we multiplied the mean percentage of cast net fishers over the coastal population of 1973-1977 by the coastal population of 1950. This mean was assumed to be constant between 1950 and the 1970s because of the overall unchanged conditions in the lagoon. The number of cast net fishers increased to 2,932 fishers in 1986 (Laë 1992) partly due to the prohibition of collective fishing techniques in Ebrié Lagoon. To estimate the number of cast net fishers for 2010, we assumed the rate of individual fishers over the coastal population declined by 20% since 1994, due to migrations caused by conflicts, and estimated a percentage of 1% for 2010. By multiplying this percentage by the coastal population for 2010, we obtained the number of cast net fishers for 2010 at 4,118 and interpolated between the previous effort estimates. Catches were assessed for the period between 1975 and 1984 (Durand *et al.* 1978; Anon. 1981; Laë 1992), which allowed to estimate the CPUE by dividing these catch estimates by the previous effort. We obtained the CPUE for 1950 as the geometric mean of the 1975-1978 CPUEs, given the overall unchanged conditions. On the other hand, the overexploitation of certain species of small pelagic fishes in the early 1980s led to a decrease in CPUE, which remained constant since then, notably because of the high adaptability of fishing villages (e.g., the prohibition of collective fishing gear). Consequently, we obtained the CPUE for 2010 as the geometric mean of the 1982-1984 CPUEs. We interpolated between the CPUE anchor points and then multiplied CPUEs by effort estimates (Table 2).

Konan (1998) reported the number of cast net fishers at 2,160 for 1996 in Aby Lagoon, which represented 0.8% of the coastal population. Given the decline in subsistence fishing using individual gear in lagoons other than Ebrié Lagoon (Verdeaux 1981), we conservatively assumed that this percentage was 20% higher in 1950 (1 %) and 50% lower in 2010 (0.4%). We then multiplied these percentages by the coastal population of 1950 and 2010 respectively and

Table 2. Effort and CPUE anchor points for the estimation of cast net fishing in Ebrié and Aby Lagoons. Interpolations are indicated by italics.

	Ebrié Lagoon		Aby Lagoon		Estimated CPUE	
Year	Effort (fishers)	Source	Effort (fishers)	Source	CPUE kg·fisher⁻¹·year⁻¹	Source
1950	1,217	Assumed	407	Assumed	810	Geometric mean 1975-1978 CPUE
1973	3,375	Durand *et al.* (1978)	*1,284*	Interpolation	*642*	Interpolation
1974	3,375	Durand *et al.* (1978)	*1,322*	Interpolation	*635*	Interpolation
1975	*2,767*	Interpolation	*1,360*	Interpolation	627	Estimated catch (Durand *et al.* 1978) by interpolated effort
1976	2,159	Laë (1992)	*1,398*	Interpolation	*738*	Interpolation
1977	*2,237*	Interpolation	*1,436*	Interpolation	849	Estimated catch (Anon. 1981) by interpolated effort
1984	*2,777*	Interpolation	*1,703*	Interpolation	730	Estimated catch (Laë 1992) by interpolated effort
1986	2,932	Laë (1992)	*1,779*	Interpolation	*725*	Interpolation
1994	2,970	Durand *et al.* (1994)	*2,084*	Interpolation	*704*	Interpolation
1996	*3,113*	Interpolation	2,160	Konan 1998	*698*	Interpolation
2010	4,118	Assumed	1,684	Assumption	662	Geometric mean 1981-1983 CPUE

obtained the number of fishers at 407 (1950) and 1,684 (2010). We interpolated linearly and multiplied the resulting effort by the CPUE estimated previously for Ebrié Lagoon (Table 2).

To estimate catches for the Grand-Lahou Lagoon, for which no data on the number of individual fishers were available, we first estimated the average annual catch by square km for the two previous lagoons and then multiplied these by the surface area of Grand-Lahou.

Personal consumption

Personal consumption was estimated by Konan (1998) at 3% of artisanal catches for 1996. We assumed that this consumption rate was constant between 1950 and 1996, and increased it by 30% in 2010, because of the increase of insecurity, which increased informal activities. We interpolated linearly to fill in the gap and then multiplied the resulting rates by the estimated artisanal marine and lagoon catches.

Tegbe (acadja) catches

The number of fishers using the *tegbe* technique was estimated to be the equivalent of 14% of fishers around lagoons (Verdeaux 1981). We first calculated the total number of fishers in Côte d'Ivoire's lagoons as the sum of previously estimated number of fishers in each lagoon between 1950 and 1969. We then interpolated to 10,000 fishers in 1979 (Cormier 1983) and to 2,898 fishers in 2010 (Pérez-Ruzafa and Marcos 2012). We interpolated to complete the time series of the total number of lagoon artisanal fishers, and then multiplied the resulting numbers by 14%. Assuming that a *tegbe* system has a similar production rate than an acadja system, i.e. around 3.4 t· acadja⁻¹· year⁻¹ (Belhabib *et al.* 2015), we multiplied this rate by the number of fishers (each fishers conservatively using one *tegbe*) and estimated *tegbe* catches between 1950 and 2010. Total subsistence catches are calculated as the sum of the three components estimated above.

Industrial catches

Industrial fisheries in Côte d'Ivoire include a domestic component, which in turn, consists of three different categories: (i) tuna purse-seiners, (ii) shrimp and fish trawlers and small pelagic purse seiners, and (ii) foreign fleets including trawlers, but mostly tuna vessels. The Canal of Vridi, opened in 1950, links Ebrié Lagoon to the sea, and led to the creation of the port of Abidjan. By providing good berthing facilities, the new port fostered the development of an industrial fishery (Koffie-Bikpo 2012), which expanded its fishing grounds from the coast of Côte d'Ivoire in the early 1950s to Liberia and Ghana in the early 1960s, and later to Mauritania (Cormier 1983).

Trawl landings were recorded by observers since 1966, along with related data on fishing effort, fishing zones and ex-vessel prices. Data on fishing zones and the time spent at sea were collected from the skippers and boat owners themselves; when this information was lacking, it was inferred from vessels of the same size class (Fonteneau and Troadec 1969); such extrapolations were performed for around 30% of the trawl fleet between 1966 and 1978 (Fonteneau and Troadec 1969). Similarly, small-pelagic purse-seine catch data was collected since 1966 by the CRO, and then by the *Projet de Développement de la Pêche Pélagique Côtière*. Catch data from the marketing services of the landing site and from skippers were collected and then compared and harmonized, while trip durations were obtained using the time of exit and re-entry to port (Fonteneau and Marchal 1970). Between 40% to 50% of the fishing trips were covered by this process (Fonteneau and Marchal 1970). Tuna catch surveys began in the early 1990s by IRD and CRO, but they became reliable only since 1996, when their catches became assessed on deck (Romagny *et al.* 2000).

Over 100,000 t of fish are transhipped annually through Abidjan port, which make catch recording very difficult, despite these efforts, the quantities and/or the geographical provenance of these catches is often not available (Chavance *et al.* 2011). Rather, the spatial resolution and the accuracy of such data are based on the good will and honesty of skippers. Herein, we reconstruct the catches taken within the Exclusive Economic Zone (EEZ) of Côte d'Ivoire, and distinguish them from catches taken outside, but landed/transhipped through Abidjan, in an effort to retrace the history of the domestic fisheries of Côte d'Ivoire and understand the reasons behind their collapse.

Domestic fisheries

Domestic catches are defined as catches taken by vessels flagged to Côte d'Ivoire and landed in Côte d'Ivoire. These could be caught within or outside the country's EEZ.

Trawl catches

Total trawl fish landings by the domestic fleet, taken within or outside the EEZ, were reported by Lassarat (1958) for 1955, Cavérivière (1979) between 1955 and 1968, Cormier (1983); Rey (1993); Kébé *et al.* (1997) between 1969 and 1995, Coulibaly (2010) between 2000 and 2005 and by Bikbo-Koffie (2010) between 2006 and 2008. On the other hand, landings taken from within Côte d'Ivoire's EEZ were reported by Cavérivière (1979) and Ménard *et al.* (2001) between 1955 and 1997. Landings as reported by Cavérivière (1979) under-estimated catches as suggested by Lassarat (1957, 1958). Therefore, we reconstructed catches based on the reported effort and CPUE, then compared these to the landings reported in the literature.

The CPUE of trawlers was estimated at 22.36 t·day^{-1} for 4 units operating 25 fishing days a month (Lassarat 1958), which translates into a CPUE of 1,677 t·trawler^{-1}·year^{-1} for 1956. The author observed a lower CPUE by experimental trawlers the previous year, i.e., 443 t·trawler^{-1}·year^{-1}. Therefore, we calculated the geometric mean of the CPUEs at 1,060 t·trawler^{-1}·day^{-1} and assumed the latter was constant between 1950 and 1956. Given the over-exploitation pattern observed in the mid-1980s (Cormier 1983), which included a growing vessel capacity and the retaining of more bycatch species, we assumed the CPUE declined by 5% between 1956 and 1984, i.e., to 1,007 t·trawler^{-1}·year^{-1}. Similarly for 2010, we assumed a decline of 15% and estimated a CPUE of 856 t·trawler^{-1}·year^{-1}, and interpolated to fill in the gaps.

The total number of fish trawlers, reported through the 1950-2010 time period (Lassarat 1958; Cormier 1983; Rey 1993; Kébé *et al.* 1997; Bikbo-Koffie 2010), was completed by a series of interpolations. The number of demersal fish trawlers and their respective GRT was reported by Cavérivière (1979) for the period between 1950 and 1980, when vessels under 300 GRT fished exclusively in Côte d'Ivoire, while trawlers with a GRT between 300 and 600 GRT fished mostly (here assumed to be 70% of the time) in Côte d'Ivoire and at a lesser extent in Sierra Leone, Liberia and Ghana (30%); finally, trawlers of GRT 600 GRT fished between Sierra Leone and Mauritania (Cavérivière 1979). We estimated the number of vessels operating within Côte d'Ivoire between 1950 and 1980 as the total number of vessels under 300 GRT to which are added 70% of the vessels between 300 and 600 GRT. We calculated the percentage of these two categories over the total for 1980, last data point for the GRT categories, and then multiplied this percentage by the total number of fish trawler for the subsequent years, 100% of the first category (300 GRT) and 70% of the second category operated within the Côte d'Ivoire EEZ. We thus obtained the number of vessels operating in Sierra Leone, Liberia and Ghana as 30% of the second category, and obtained the number of vessels operating from Sierra Leone to Mauritania (GRT600) as the difference between the total number of vessels and the sum of the two first GRT categories. To estimate total catches by these two categories, we first estimated the CPUE per GRT by dividing the CPUE per trawler of the first category by 300 GRT between 1950 and 2010 and then multiplied the resulting CPUE (t·trawler^{-1}·GRT·year^{-1}) by 450 (average GRT of the second category), and 600 GRT for the third category. Finally, we multiplied the resulting CPUEs for both categories by their respective effort. We assumed catches by vessels over 300 GRT from outside Côte d'Ivoire started declining since 1984 to zero in 1990, given no indication of access agreements between the Côte d'Ivoire and any other country in Africa, and their declaration of EEZs. [Ghana's distant-water fleet suffered a similar fate (Atta-Mills *et al.* 2004)]. The remaining catch was allocated to the Côte d'Ivoire's EEZ.

While Cavérivière (1979) refers to landings from Sierra Leone, Liberia and Ghana for 30% of the vessels ranging between 300 and 600 GRT, the same author, in 1978 reported that landings were taken, between 1966 and 1976, only in Ghanaian and Liberian waters, while Fonteneau and Troadec (1969) reported no landings from Liberia. We calculated the percentage of landings taken from Sierra Leone and Ghana by dividing the landings taken from the EEZ-equivalent waters of each country by the total of the two between 1966 and 1976 and assumed these percentages were constant from then to 1990 (when catches from outside Côte d'Ivoire were zero), and backwards from 1960 to 1966.

Catches taken between Sierra Leone and Mauritania, i.e., mainly from Guinea and Senegal (Cavérivière and Marcille 1978), from Guinea Bissau (Cavérivière 1978), and from Gambia and Angola, were only mentioned casually in the 1960s (Fonteneau and Troadec 1969) and made up only 3% of the Ivorian catch in 1969. They were not included in the present study. However, we allocated a third of the catch taken from outside Côte d'Ivoire by trawlers of over 600 GRT to each country's EEZ (Guinea, Senegal and Guinea Bissau).

Shrimp trawl catches

Shrimp trawl catches were reported from 1969, when the fishery began to 1981, when the fishery collapsed (Cormier 1983; Rey 1993; Kébé *et al.* 1997). These catches are taken from both Côte d'Ivoire and Nigeria, but catches post-1981, after the economic collapse of Côte d'Ivoire's industrial fishery in 1978-1979 (Garcia and Poinsard 1989), were likely from Nigeria (FAO 1985). We assumed these catches were reliable given the monitoring system used then, and divided them by the number of shrimp trawl vessels obtained from various sources (Cormier 1983; Rey 1993) to obtain a series of CPUEs averaging at 47 t· vessel^{-1}· year^{-1}. We assumed that this CPUE was constant later on, as vessels adapted to decreasing catches (and ultimately to the collapse of the fishery in Côte d'Ivoire) by fishing in Nigerian waters. We then multiplied this CPUE by the reported number of vessels between 1982 and 2010 (Kébé *et al.* 1997; Bikbo-Koffie 2010). The number of vessels operating in Nigeria and the number of fishing days between 1970 and 1975 were reported by FAO (1985) along with the catch for 1973 which allowed to estimate the CPUE at 0.27 t·vessel^{-1}· day^{-1}. Assuming a constant CPUE from 1970 to 1975, we estimated catches taken from Nigerian waters for the same time period. We also considered that all catches after 1981 were taken from Nigeria (FAO 1985). The difference between catches taken from Nigeria and total catches represents the catch taken by domestic shrimp trawlers from Côte d'Ivoire.

Industrial small-pelagic catches

Although the number of small pelagic purse-seiners was documented throughout the 1950-2010 time period (Lassarat 1958; Bouberi 1981; Cormier 1983; Rey 1993; Kébé *et al.* 1997; Bikbo-Koffie 2010), along with catches for the periods 1967-1995 and 2000-2008 (Cormier 1983; Cury and Roy 1987; Rey 1993; Kébé *et al.* 1997; FAO 2009; Bikbo-Koffie 2010; Coulibaly 2010), little is known on the geographical distribution of catches beyond the EEZ of Côte d'Ivoire . The few data points illustrating the origin of the purse-seine catch taken from Côte d'Ivoire, Sierra Leone, Senegal, Ghana and Congo covered only years within the period between 1966 and 1979 (Hem 1976; Cavérivière and Marcille 1978; Bouberi 1981, 1984a, 1984b). To complete the time series of total small pelagic catches, i.e. taken within and outside Côte d'Ivoire EEZ, we estimated the average CPUE for the early 1980s based on the effort and the catch documented by Bouberi (1981, 1984b) at 1,345 t· vessel^{-1}· year^{-1}. We assumed the CPUE for 1950 was 30% higher (1,748 t· vessel^{-1}· year^{-1}), thus reflecting in one hand the impact of the collapse of the sardinella fishery of the 1970s and the quota limitations imposed by fishers syndicates in the 1980s (Bouberi 1984a). We multiplied this CPUE by the number of vessels for 1950 and obtained a catch of 3,497 t. Given the decline in CPUE and number of vessels in the 2000s (Pigeaud 2012), we assumed catches declined by 5% between 2008 and 2010. We then interpolated linearly to fill in the gaps between 1950 and 2010.

We interpolated catch estimates from zero in 1950 to the first anchor point available for catches taken from Sierra Leone (1967), Senegal (1975), Ghana (1966) and Congo (1974) and then from the last anchor point for Sierra Leone and Senegal (1979), Ghana (1978) and Congo (1975) to zero in 2010 for Sierra Leone and Senegal, and zero in 1979 for Ghana and Congo. The difference between total catches taken within and outside Côte d'Ivoire EEZ and the sum of catches taken from Sierra Leone, Senegal, Ghana and Congo, represents the domestic small pelagic catches taken within Côte d'Ivoire EEZ.

Industrial tuna catches

Tuna fisheries surveying for foreign vessels began only in 1990 and became efficient in 1996 (Romagny *et al.* 2000). On the other hand, literature review showed domestic tuna catches as early as 1957 when experimental tuna fishing began (Lassarat 1958), for 1965 (Ecoutin 1992) and between 1970 and 1986 (Cavérivière and Marcille 1978; Cormier 1983; Ecoutin 1992; Rey 1993; Kébé *et al.* 1997), when domestic tuna seiners stopped operating in Côte d'Ivoire (Rey 1993). These catches included only main species of skipjack (*Katsuwonus pelamis*) and albacore (*Thunnus alalunga*). The bycatch, called "faux poissons"[2] meaning "false fish", and which is "a peculiar term for an important by-product of the purse-seine fishery in West Africa and particularly in Abidjan"(Amandè *et al.* 2010) was not included in official statistics (Cavérivière and Marcille 1978). We completed the time series by interpolating linearly between the anchor points, assuming tuna domestic catches were correctly reported.

Foreign catches

Demersal trawl fisheries

Herein we reconstruct Chinese trawl catches within Côte d'Ivoire, given the large number of legal Chinese trawlers in the country's EEZ. FAO (2008b) reported that 9 Chinese trawlers were authorized to fish in Côte d'Ivoire EEZ, with a CPUE of around 415 t·vessel^{-1} for 2005. Other estimates show a CPUE of 1,252 t·vessel^{-1}·year^{-1} (Pauly *et al.* 2013). We assumed that China started fishing in Côte d'Ivoire in 1990, at the time when foreign trawlers were reported for the first time within the Ivoirian EEZ (FAO 2008b), and that the effort was constant between 2005 and 2010; then, we linearly between zero in 1990 and the first data point in 2005. Total Chinese trawl catches from Côte d'Ivoire are calculated as the product of effort and a CPUE of 808 t·vessel^{-1}·year^{-1}, i.e., the mean between values in (FAO 2008a, 2008b; Pauly *et al.* 2013).

---

[2] This sector is treated further below in the section on "faux poissons."

Tuna fisheries

Scarce documentation is available on foreign tuna fishing in Côte d'Ivoire. When reviews are found, often the geographical allocation of catches remains confusing, as literature refers to landings in "Abidjan" rather than catches from Côte d'Ivoire. A few hints show the number of vessels within Côte d'Ivoire waters, and/or describe the presence or the absence of an agreement for tuna fishing. For example, the first agreement with France was signed right after independence in 1961 (Cormier 1983; Folsom *et al.* 1993). It is reasonable to assume that Spain and Senegal, for which the number of vessels was reported for 1972 (Cormier 1983), also began fishing in Côte d'Ivoire in 1961, given that Senegalese vessels were mainly from Spanish and French origin (Belhabib *et al.* 2014). A total number of 270 tuna vessels were reported for 1972, of which 22% were Japanese, 30% French, 18.5% Korean, 18.5% Taiwanese, 6% Spanish, 2% Senegalese and 3% allocated evenly between Yugoslavia, the United States, Canada and Israel (Cormier 1983). We assumed all fleets, excluding those from Spain, Senegal and France, started fishing in 1968, when domestic tuna fishing resumed (Rey 1993). We kept this effort constant in the 4 years from 1972 and 1975, which is the average duration of a fishing agreement. We then interpolated to zero in 1991 for Japan, Korea, Taiwanese, Senegal, Yugoslavia, United States, Canada and Israel, given the absence of any reference indicating an agreement with these countries in the 1990s (in contrast to the agreement with the EU). Similarly, we interpolated data for countries of the European Union (EU), i.e., Spain, France and Portugal for which the effort was indicated in the agreements signed with the EU (Table 3). We completed the effort time series by performing interpolations as needed.

Table 3. Foreign tuna fleet anchor points, 1950-2010.

Year	Japan	France	Korea	Taiwan	Spain	Senegal	Yugoslavia	US	Canada	Portugal	Israeli	Reference
1960		0			0	0						Assumption
1961[a]												
1968	0		0	0			0	0	0		0	Assumption
1972	59	81	50	50	16	5	2	2	2		2	Cormier (1983)
1973	59	81	50	50	16	5	2	2	2		2	Assumption
1974	59	81	50	50	16	5	2	2	2		2	Assumption
1975	59	81	50	50	16	5	2	2	2		2	Assumption
1978[b]											0	Lankester *et al.* (2001)
1991-1993	0	45	0	0	45	0	0	0	0		0	European Economic Community (1990); Folsom *et al.* (1993)
1994-1996	0	45	0	0	45	0	0	0	0		0	European Economic Community (1990); Folsom *et al.* (1993)
1996	0	45	0	0	45	0	0	0	0	0	0	OECD (2000)
1997-1999	0	25	0	0	30	0	0	0	0	5	0	European Union (2004); OECD (2000)
2000	0	30	0	0	36	0	0	0	0	5	0	European Union (2004)
2001	0	30	0	0	36	0	0	0	0	5	0	European Union (2004)
2002[c]	30	30	0	0	37	0	0	0	0	5	0	European Union (2004); Oceana (2004)
2003	30	30	0	0	37	0	0	0	0	5	0	European Union (2004); Oceana (2004)
2004	30	20	0	0	24	0	0	0	0	5	0	eur-lex.europa.eu/Index.do; Oceana (2004)
2005	30	20	0	0	24	0	0	0	0	5	0	eur-lex.europa.eu/Index.do; Oceana (2004)
2006	30	20	0	0	24	0	0	0	0	5	0	eur-lex.europa.eu/Index.do; Oceana (2004)
2007	30	20	0	0	24	0	0	0	0	5	0	eur-lex.europa.eu/Index.do; EU (2008)
2008	30	20	0	0	24	0	0	0	0	0	0	eur-lex.europa.eu/Index.do; EU (2008)
2009	30	20	0	0	24	0	0	0	0	0	0	eur-lex.europa.eu/Index.do; EU (2008)
2010	30	20	0	0	24	0	0	0	0	0	0	eur-lex.europa.eu/Index.do; EU (2008)

a) First agreement here with France (Cormier 1983);
b) First agreement here, reciprocity not implemented and only Guinea Bissau was fishing in Côte d'Ivoire (Lankester et al. 2001);
c) Agreement signed with Japan for 30 vessels but the agreement was never used (European Union 2004).

The next step was to estimate total catches of these vessels within the EEZ of Côte d'Ivoire or the EEZ-equivalent waters prior to the declaration of the EEZ in 1977. First, we estimated total catches of these vessels within and outside Côte d'Ivoire waters, based on the CPUE of domestic tuna vessels from Côte d'Ivoire. We obtained the latter by averaging the CPUEs obtained by dividing the estimated domestic tuna catch by the domestic effort between 1957 and 1986, i.e., 747 t·vessel^{-1}·year^{-1}. We multiplied this CPUE by the number of vessels assuming that the decrease of the CPUE due to over-exploitation would be compensated by the increase in vessel efficiency and the decrease in vessel number over time. We multiplied the resulting catch by the average percentage of the catch originated from Côte d'Ivoire, i.e., 6% (Menard *et al.* 2000; European Union 2004). Although these percentages were reported only for the EU fleet, we assumed that it applied to all other fleets, given that they hold agreements with other West African countries, except for Israel, whose entire catch was assumed to be from the Côte d'Ivoire EEZ.

"Faux poisson"

Chavance *et al.* (2011) timed the beginning of the 'faux poissons' fishery back to the early 1980s, when "the development of the log fishing practice for purse seiners produced quantities of juvenile major tunas, minor tunas or by-catch species that started to be landed in Abidjan for consumption according to a Nigerian (Houssa) recipe, the garba", a cheap meal that gradually gained popularity (Romagny *et al.* 2000).

Catches of "faux poisson" were grossly under-estimated in the 1980s (Romagny *et al.* 2000) and are considered absent from more recent official statistics (Amandé *et al.* 2010). While these were estimated by CRO based on customs reports, the nature of the activity that requires payment allows for a large gap in estimations, a bias that drives catch estimates downwards as fishers would report less to pay less. Also, very often, agents will not report these catches. Estimations by CRO, as opposed to official numbers improved overtime (Amon Kothias 1986; Romagny *et al.* 2000) from very poor in the early 1980s to relatively better in the late 1990s (Romagny *et al.* 2000). Catches reported as 'faux poissons' by the Department of Fisheries (DAP) in national reports remain relatively low and unreliable when compared to catches estimated more realistically by CRO, as the former were obtained via logbooks while the latter by estimation onsite (Romagny *et al.* 2000). Even in 2010, accounting for 'faux poissons' landings remained informal, and many issues were observed by Chavance *et al.* (2011), notably regarding the localization of the catch, the gear, and the amount of the catch. The authors noted that the activity remained relatively undeclared in official statistics.

While many fleets operate within Côte d'Ivoire EEZ and the Central Eastern Atlantic area, 'faux poissons' landings are reported only by European, Japanese, South Korean, Ghanaian and Guinean vessels and vessels flying flags of convenience of countries such as Cambodia (Chavance *et al.* 2011). We first attributed an underreporting rate of "grossly unreliable/underestimated", "low reliability" and "good reliability" to CRO estimated catches (Romagny *et al.* 2000) for the periods considered by the author. We assumed catches were under-estimated by 60% for 1988-1991, 40% in 1991-1994, 30% between 1995 and 1999 and interpolated to 20% (conservatively) in 2010. We first estimated total catches, i.e., added the unreported component for the EU fleets by multiplying the former percentages by the reported catch and then adding it to the reported catch between 1991 and 2010. These estimates include Spain, France and Portugal for the most recent periods. Then, we estimated Spanish, French and Portuguese 'faux poissons' bycatch rates by dividing the catch of 'faux poissons' by the corresponding total tuna catch, i.e., tuna catches landed in Abidjan regardless of the catch area, between 1991 and 2010, and interpolated from zero in 1981 (Chavance *et al.* 2011) to the first estimated bycatch rate in 1991, i.e. 35%. Given the similarities between the EU fleets and the Senegalese (mainly French and Spanish based in Dakar) and domestic fleets (given that tuna fishing was introduced to Côte d'Ivoire by France (Lassarat 1957, 1958; Belhabib *et al.* 2014), we assumed the same bycatch rates and applied them to the estimated tuna catch by the Senegalese and Côte d'Ivoire fleets.

Japanese tuna catches were estimated between 1969 and 1990, a period during which Japan had an agreement with Côte d'Ivoire (see foreign tuna catch section), while "faux poissons" catches were only reported for Ghana, also known to have a significant number of Japanese tuna boats flagged to it (Nunoo *et al.* 2014), and covered only the period between 1988 and 2009 (Chavance *et al.* 2011). Therefore, we could only estimate bycatch rates for the three overlapping years (1988-1990). We interpolated bycatch rates between zero in 1981 and 29% estimated herein in 1988 and multiplied the resulting time series by Japan's tuna catch, thus obtaining Japanese "faux poissons" catches landed in Abidjan. Similarly, knowing that Korea also used to reflag its tuna boats to Ghana, we used the same bycatch rates and applied them to the Korean tuna catch between 1981 and 1990, when Korea stopped operating in Côte d'Ivoire as "Korea". We used these same bycatch rates for the other fleet that had agreements with Côte d'Ivoire and landed their catches in Abidjan, i.e., Israel, Canada, United States, Yugoslavia and Taiwan. For Ghana, Guinea and Cambodia, for which only 'faux poissons' catches were reported by Chavance *et al.* (2011), we calculated the unreported catch by multiplied the reported catch by the underestimation rates alluded above based on the reliability of catch estimates as described by Romagny *et al.* (2000). Although only 6% of the foreign catches landed in Côte d'Ivoire are taken from the country's EEZ, the reported landings of 'faux poissons' from outside the EEZ were likely included in the data submitted to FAO.

Illegal fisheries

With over 600-700 fishing vessels visiting the ports of Côte d'Ivoire, there are no inspectors responsible for fisheries compliance (SIF 2010). Furthermore as of 2011, Côte d'Ivoire did not have patrol boats and relied on it its navy to monitor fisheries and the Monitoring Control and Surveillance (MCS) unit and Vessel Monitoring System (VMS) were not functional (Manning 2011). This fostered illegal fishing, e.g., by over 40 Chinese trawlers in 2004 and 2005 (Anon. 2007) of which only 8 and 9 vessels were legal, respectively. For 2010, illegal catches were estimated at 55,116 t (Valdmanis and Akam 2010). We multiplied the number of illegal Chinese pair trawlers, i.e., 32 and 31 respectively for 2004 and 2005 by a CPUE of 1,252 t·vessel^{-1}·year^{-1} (Pauly *et al.* 2013), slightly higher than the average CPUE estimated for legal trawlers, and then interpolated starting from 0 in 1990, as 1991 coincides with the beginning of Chinese fishing operations in Côte d'Ivoire.

Discards

Trawlers

Discard rates observed and reported for Côte d'Ivoire are relatively low, as only a few species are discarded within the EEZ. Furthermore, these low rates have already been declining in recent years reflecting that trawlers keep their fish of lower value (Cavérivière 1983). Discards rate of 15% were reported from 1958 and 1959 (Cavérivière 1983), which we assumed constant for the 1950s. For 1966 and 1967, we used the acoustic trawling survey report by Troadec *et al.* (1969), which showed that of over about 1,940 kg· h^{-1} of catch, 1,550 kg·h^{-1} were commercial species, the remainder being discarded. Thus, relying on the assumption that the survey trawler performed similarly than other trawlers (300 CV and mesh size of trawl 40 mm) over the same fishing grounds, we obtained a discard rate of 20% of total catches, which was kept constant between 1966 and 1969 (Troadec *et al.* 1969). For 1983, Cavérivière (1983) reported a discard rate ranging between 5% and 30%, which is herein averaged at 18% for demersal trawlers. Knowing that discard rates have been declining (Cavérivière 1983), we assumed a decline of 20% for 2010, i.e., a discard rate of 14%. We applied these discard rates to the estimated domestic trawl catch within and outside Côte d'Ivoire EEZ. For the Chinese legal trawl fleet, we applied a discard rate of 40% (Belhabib *et al.* 2013), while for the illegal pair trawl fleet, we applied a discard rate of 80% of the trawl catch (Belhabib *et al.* 2013).

Similarly, the discards of the Spanish and French tuna fleet were estimated at 14% for 1998 (Romagny *et al.* 2000), which we assumed constant between 1998 and 2010 across fleets of different origins. We assumed discards generated by tuna fleets were conservatively 20% higher in 1950 given the decline in tuna discards due to development of a market for "faux poissons" (Romagny *et al.* 2000; Chavance *et al.* 2011). We interpolated and applied these discard rates to the estimated tuna catch taken within Côte d'Ivoire by both the domestic and foreign fleets.

Cavérivière (1983) observed that around 1% of small pelagic purse-seine catches were discards and were constituted mainly of West African ilisha (*Ilisha Africana*). We assumed this discard rate was constant between 1950 and 2010 and applied it to the small pelagic domestic purse-seine catch within Côte d'Ivoire.

Species disaggregation

We disaggregated subsistence lagoon and artisanal catches using the species composition described by Laë (1992). For industrial catches, we derived a species disaggregation from the reported landings dataset (supplied by the FAO), while for the foreign component, we disaggregated catches based on FAO (2008b). We disaggregated discards based on the description by Cavérivière (1983) and Romagny *et al.* (2000).

RESULTS

Artisanal

Total artisanal catches were estimated at over 2.9 million t between 1950 and 2010, 67% of which were marine. Lagoon artisanal catches were estimated at 982,300 t during the 61 years' time period. Lagoon catches increased from 14,200 t in 1950 to a peak of 22,000 t in 1979, right before they collapsed due to the decline of the small pelagic catches and the proliferation of collective fishing gear (Figure 3). Lagoon catches varied later on, while increasing toward their second peak of 15,800 t in 1998. They have been declining since, due to increasing migrations towards the coast (Figure 3). Artisanal marine catches decreased slightly in the early 1950s, due to the conflict between Côte d'Ivoire and Benin, which drove fishers from the latter country to leave Côte d'Ivoire. Artisanal catches increased again, to 35,000 t in 1984 and then decreased to 25,000 t in 2010, their minimum since 1957 (Figure 3).
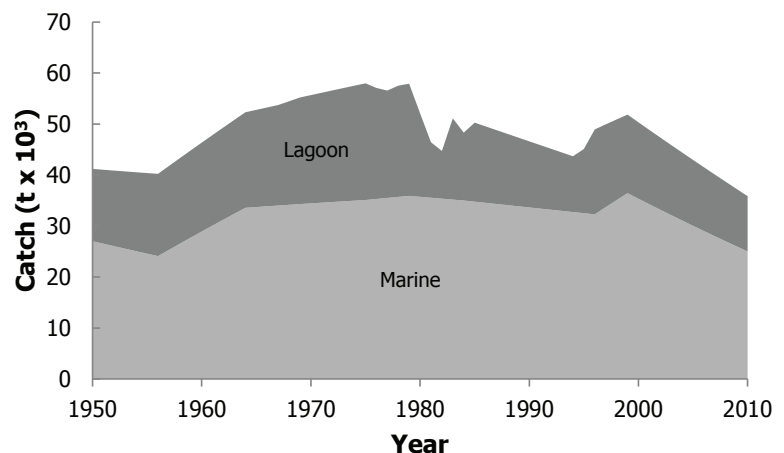

Figure 3. Reconstructed artisanal marine and lagoon catches from Côte d'Ivoire EEZ, 1950-2010.

Subsistence

Subsistence catches were estimated at 523,000 t over the 1950-2010 time period, of which 456,100 t were from the lagoons of Côte d'Ivoire (83%). Lagoon subsistence catches taken mostly by cast nets and *tegbe* systems increased to a peak of 9,100 t in 1977, and then decreased to less than 6,500 t in 2010 as the use of Tegbe systems fishers migrating towards the coast (Figure 4). Subsistence marine catches, including the catch taken home by artisanal fishers, were estimated at 67,200 t·year⁻¹ between 1950 and 2010, less than 12% of the total subsistence catch, and, overall, remained relatively constant at around 1,000, with slight increases from the 1970s to the 1990s (Figure 4).

Industrial domestic

Total industrial domestic catches were estimated at 2.9 million t between 1950 and 2010, around a third of which were taken from outside of Côte d'Ivoire EEZ. Small pelagic purse-seine contributed over half of total domestic catches, followed by demersal catches with around 40% the total domestic industrial catch, while tuna catches including 'faux poissons' catches represented only 7%. The latter number is explained by the fact that the domestic tuna fleet operated only between the mid-1960s and the mid-1980s. Total catches increased from around 6,200 t in 1950 to a first peak of around 78,000 t in 1972, corresponding to the peak of demersal and shrimp trawl catches and a second peak of around 80,000 t in 1981 corresponding to the peak of tuna fisheries (Figure 5). Catches remained relatively constant at around 78,000 t·year⁻¹ on average during that time, which corresponds to the period of economic prosperity. Thereafter, catches declined steadily to less than 22,048 t in 2010 (Figure 5).

Domestic demersal trawl catches were estimated at 1.5 million t between 1950 and 2010, 20% of which were caught from outside Côte d'Ivoire, but landed in Côte d'Ivoire ports. Catches taken from Côte d'Ivoire EEZ increased from around 2,400 t in 1950 to a peak of 35,600 t in 1966, declined to a minimum of 3,300 t in 1982, increased gradually to a second peak of around 32,900 t in 1996, with increasing number of domestic trawlers returning to fish in Côte d'Ivoire, to decrease thereafter to around 8,800 t in 2010. In contrast, domestic demersal trawl catches taken from outside Côte d'Ivoire EEZ reached their maximum between 1972 and 1980, a period of economic prosperity, before decreasing gradually to zero in 1990 (Figure 6). The decrease of catches taken from the outside coincides with the increase of catches taken from within Côte d'Ivoire EEZ (Figure 6).
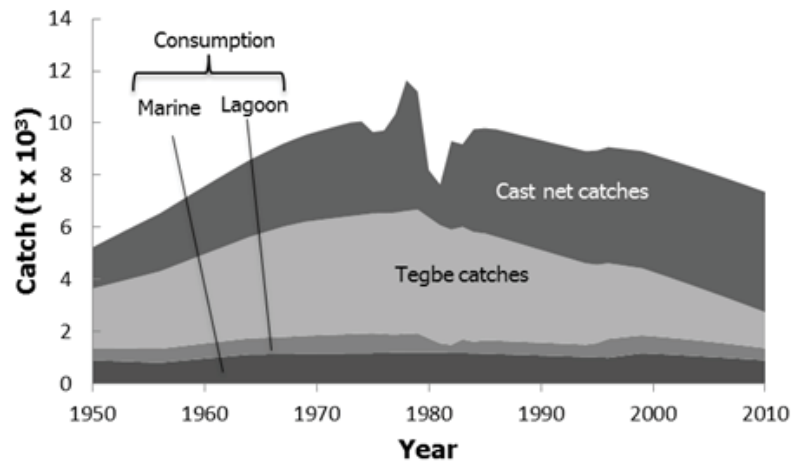

Figure 4. Reconstructed subsistence catch from Côte d'Ivoire , 1950-2010.
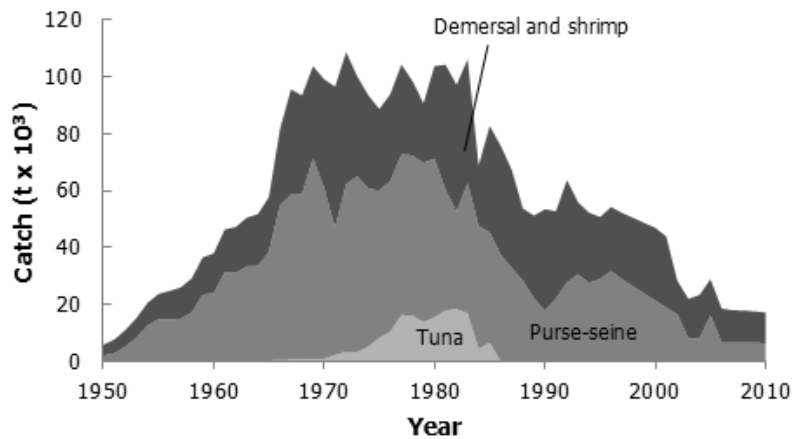

Figure 5. Total industrial domestic catches of the fleets of Côte d'Ivoire within and outside Côte d'Ivoire EEZ by gear.
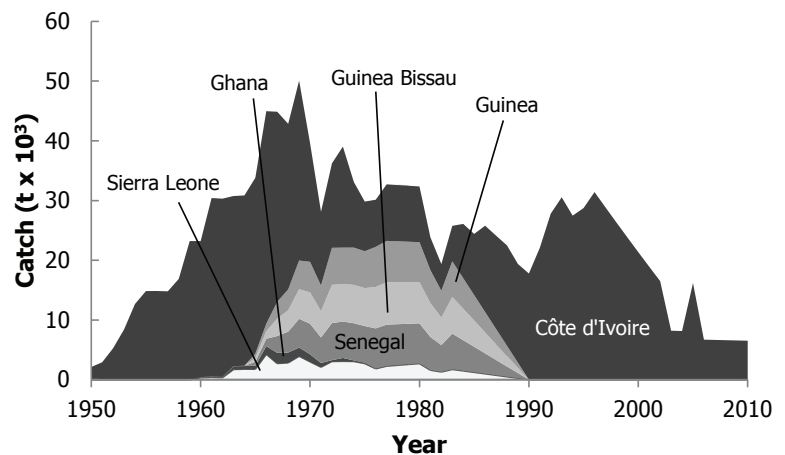

Figure 6. Total industrial domestic catches of the demersal trawl fleet within and outside Côte d'Ivoire EEZ..

The same pattern is observed for shrimp catches, which peaked at around 700 t in 1971 (mostly from Côte d'Ivoire EEZ), and then declined to its peak again in 1988 (330 t) and 1996 (280 t), all of which were caught in Nigeria, before collapsing (Figure 7).

Tuna catches (including "faux poissons") were estimated at 191,400 t between 1950 and 2010. Tuna catches started at around 250 t in 1957 and increased to 20,615 t in 1981, after which 'faux poissons' started to be landed in Abidjan by the domestic tuna fleet and increased to a peak of 1,100 t in 1983, corresponding to a tuna catch of 18,100 t (Figure 8). Domestic tuna fisheries collapsed as domestic tuna boats stopped operating in 1987 due to the economic crisis. A small component of 'faux poissons' was reported as being domestic, although, a large fraction of it was landed in Abidjan by foreign fleets.

Small pelagic purse-seine catches totalled 1.5 million t between 1950 and 2010, most of which was caught within Côte d'Ivoire EEZ. Catches increased from around 3,800 t in 1950 to a first peak of 56,100 t in 1971, decreased to 21,300 t in 1979 due to the decline in the number of boats to increase again to a second peak of 44,400 t in 1982 after catches from outside Côte d'Ivoire EEZ started declining, and then decreased gradually to 13,200 t in 2010 (Figure 9).

Industrial foreign catches

Total foreign catches were estimated at over 989,000 t from 1950 to 2010, 58% of which were caught by illegal trawlers (578,500 t), 32% by the tuna fleets, including 'faux poissons' catches within Côte d'Ivoire, with the remainder caught by Chinese legal trawlers.

Total catches by the tuna fleet (excluding 'faux poissons') increased from around 469 t in 1961, when the fishery began to a peak of 14,000 t·year^{-1} on average during the early 1970s and then declined to 2,100 t in 2010 (Figure 10). Tuna catches by France and Spain dominated over the 1950s-2010 time period, while catches by Japan, Korea, Taiwan and Israel peaked in the early 1970s to be zero later on Figure 10.

'Faux poissons' catches were estimated at around 30,300 t between 1950 and 2010, which represented the equivalent of 10% of the tuna catch. 'Faux poissons' catches increased from 200 t in 1980 with the introduction of the log fishing practice in the tuna purse-seine fishery, to a peak of around 2,000 t in 1993, and then remained more or less constant thereafter (Figure 10).

Figure 7. Total industrial domestic catches of the shrimp trawl fleet within and outside Côte d'Ivoire.

Figure 8. Total industrial domestic catches of the tuna fleet and its 'faux poissons' bycatch within Côte d'Ivoire EEZ.

Figure 9. Total industrial domestic catches of the tuna fleet and its 'faux poissons' bycatch within Côte d'Ivoire EEZ.

Legal Chinese trawl catches were estimated at 94,500 t between 1990, when they began, and 2010. Catches increased from zero in 1990 to a maximum of 7,300 t in 2005, then remained relatively constant (Figure 10). Illegal Chinese trawl catches increased from zero in 1990 to over 55,100 t in 2010, and then totalled over 578,500 t.
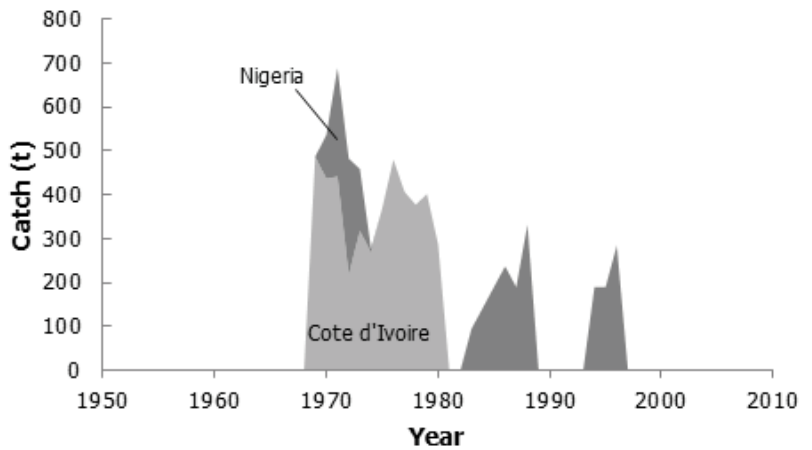
Discards

Discards within Côte d'Ivoire waters were estimated at over 777,400 t from 1950 to 2010, most of which were by illegal trawlers operating within Côte d'Ivoire EEZ (60%), followed by the domestic and the foreign fleets with 27% and 14% respectively.

Discards by the domestic fleets increased from around 360 t in 1950 to a peak of 7,400 t in 1966 with the peak of industrial trawl catches. Discards by the domestic fleet within Côte d'Ivoire EEZ decreased thereafter, which corresponds with the start of the domestic fleet venturing outside Côte d'Ivoire waters (Figure 11). Domestic discards increased thereafter to a second peak of 5,100 t·year^{-1} in the mid-1990s to decrease again to around 1,000 t in 2010 (Figure 11).

Figure 10. Total foreign legal catches from Côte d'Ivoire, 1950-2010.

Discards by foreign tuna fleets were estimated at 43,400 t from 1950 to 2010, increasing from 66 t in 1961 to a peak of 2,200 t·year^{-1} between the early and the mid-1970s, then decreasing to less than 300 t in 2010 (Figure 10). Discards by the legal trawl (China) fleet, on the other hand, increased steadily from 320 t in 1990 to around 4,500 t in 2005, a level at which they remained (Figure 11). Illegal trawl discards represented the overwhelming majority of discards, with over 462,800 t from 1950 to 2010, increasing from around 2,300 t in 1990 to around 44,100 t in 2010 (Figure 11).

'Faux poissons' from outside Côte d'Ivoire EEZ

Total foreign 'faux poissons' catches from outside Côte d'Ivoire EEZ landed in Abidjan were estimated at over 599,300 t between 1950 and 2010, of which about 374,200 t (62%) were reported to FAO as Côte d'Ivoire catch. 'Faux poissons' catches increased rapidly since the Fish Aggregating Device was introduced in the early 1980s, and peaked twice, in 1993 with around 29,800 t and in 2000 with around 28,600 t (Figure 12). Catches reached a maximum in 2010 (Figure 9). Unreported catches of 'faux poissons' declined as reporting improved, from 13,800 t·year^{-1} on average in the 1980s to less than 5,200 t in 2010 (Figure 12).

Total catches

FAO data reported by Côte d'Ivoire include catches of 'faux poissons' taken by foreign fleets from outside the EEZ of Côte d'Ivoire which are recorded locally. Similarly, catches taken by Côte d'Ivoire from other countries' EEZs were reported to the FAO. Total domestic reconstructed catches were estimated at 5.6 million t over the period from 1950 to 2010 of which only 2.6 million t was reported to FAO. Total removals from Côte d'Ivoire EEZ increased from 52,700 t in 1950 compared to 14,600 t reported to FAO to 105,100 t·year^{-1} on average from the early 1970s through the early 1980s compared to 43,000 t·year^{-1} reported to the FAO after removing 'faux poissons' catches, which started being reported in 1981. Domestic catches within Côte d'Ivoire EEZ declined steadily thereafter to less than 65,500 t in 2010 compared to 56,889 t reported to FAO. It is herein strongly suspected that a large portion of the miscellaneous marine fish component is taken by foreign fleets from EEZs outside of Côte d'Ivoire and landed

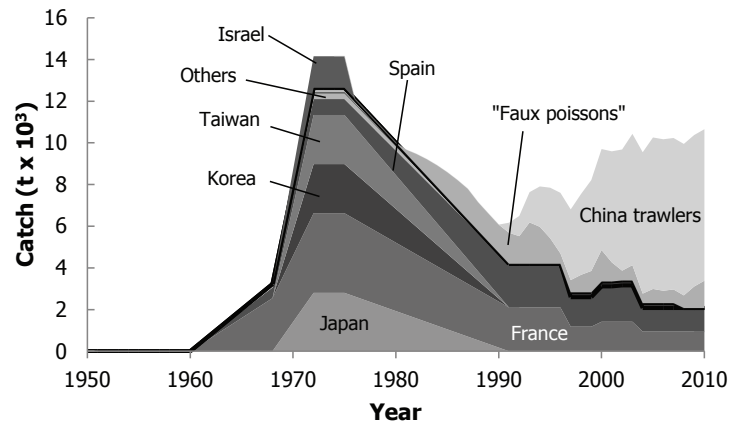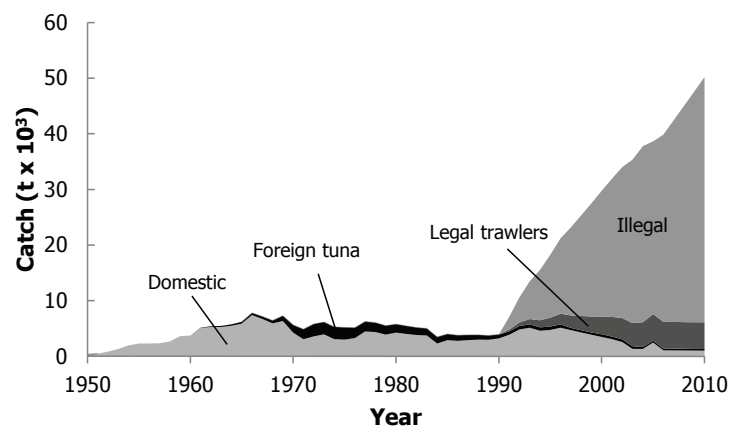**Figure 11.** Total reconstructed discards by domestic and foreign fleets within Côte d'Ivoire EEZ, 1950-2010.
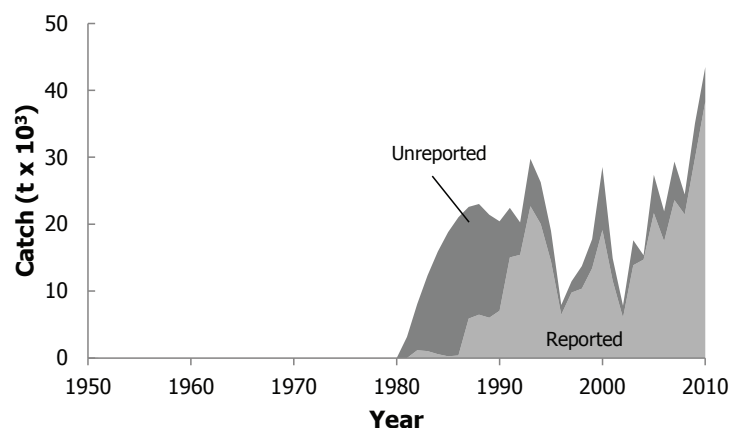

Figure 12. Total 'faux poissons' caught by foreign fleets outside Côte d'Ivoire EEZ and landed in Côte d'Ivoire ports, 1950-2010.

in Abidjan then reported to the FAO as being domestically caught. In fact one strong reason for the increase in reported landings, which doubled in 2010, seems to be due to the reporting of around 15,000 t of 'faux poissons'. This is supported by the fact that literature refers to a large part of these catches as 'reported', while many reports from the CRO include reported 'faux poissons' catches. When these are filtered out, catches decline (Figure 13).

Overall total removals from Côte d'Ivoire EEZ (domestic and foreign) were estimated at around 7.0 million t between 1950 and 2010. Catches increased and remained relatively constant at 116,000 t·year⁻¹ on average between the mid-1960s when Côte d'Ivoire signed agreements for foreign tuna fishing (mainly), and the early 1980s, when the economy collapsed. Catches decreased slightly in the 1990s and increased again due to increasing illegal catches and be over 167,000 t in 2010.

DISCUSSION

Total catches in Côte d'Ivoire were estimated at 7.1 million t between 1950 and 2010, of which 5.6 million t were caught domestically within Côte d'Ivoire EEZ. Total reconstructed domestic catches exhibit a constant decline since the mid-1980s due to poor economic conditions and over-exploitation, in contrast to the increasing trend suggested by the data supplied to the FAO. The latter is primarily due to a massive increase in 'faux poissons' catches landed by foreign fleets but reported by Côte d'Ivoire. This is dangerous, as it masks the decline in domestic catches from Côte d'Ivoire EEZ. Thus, not only is the over-exploitation problem hidden, but it suggests the sector to be flourishing, while in reality is far from the truth.

The symptoms of this decline are further illustrated through a general over-exploitation of the Côte d'Ivoire EEZ (Cormier 1983), the collapse of the shrimp fishery which is believed to be the result of artisanal shrimp fishing in lagoons (Garcia and Fonteneau 1971), the tuna fleet which went "out of business" as early as the late 1980s, the general decrease in the number of boats operating within and outside Côte d'Ivoire and even the proliferation of unwanted species such as triggerfishes in the early 1970s (Troadec and Garcia 1979). Despite this, artisanal fisheries still retain an important role with around 50% of total domestic catches. Indeed, their role has increased as industrial fisheries declined. The constraint to fisheries exacerbated by poor economic conditions, has driven artisanal fishers to adopt diverse adaptation strategies to avoid suffering a similar fate. For example,

Figure 13. Reconstructed total catch for Côte d'Ivoire EEZ, 1950-2010, by a) sector with official reported data overlaid as a line graph and b) taxon with "Others" consisting of 78 additional taxonomic categories.

Ecoutin (1992) shows that the pirogues of Côte d'Ivoire have evolved in size, capacity and motorization from those described by Lassarat (1958), thus increasing their reach and fishing grounds, a pattern also observed elsewhere, e.g. Senegal (Belhabib *et al.* 2014). This is further illustrated by the disappearance of motors with low power (Ecoutin 1992). Fishers also adapted to other conditions; for example, droughts in the 1970s and 1980s in Niger delta in Mali drove fishers to migrate to the Côte d'Ivoire fishing grounds (Njock and Westlund 2010). Another condition that strongly impacted the fisheries of Côte d'Ivoire is related to conflicts and the migrations they incur. The Ebrié Lagoon which was once "filled with fish" (Chenery 1875) has witnessed changes in the populations through migrations from the conflicted areas of the North, which translated into increasing catches. Later on, these catches decreased due to over-exploitation and conflicts that again drove fishers to migrate towards the already overexploited coastal marine fisheries. This describes a chaotic situation where artisanal fishers of Côte d'Ivoire become trapped between socio-political conflicts, the desire for a better life and over-exploitation triggered in part by the large number of illegal fishing vessels operating in Côte d'Ivoire.

Another effect of the collapsing economy was the devaluation of the Franc CFA, which has increased the price of fish and thus reduced fish consumption (Akindes 1995). The increase of post-conflict consumption of fish (Dabalen and Saumik 2013) is due in part to the increase in informal food business (Akindes 1995), i.e, subsistence fishing through the use of cast nets as documented herein. Furthermore, the role of fish in post-conflict diets appears to have increased (Kouame and Enoh 2011), thus giving fish an even greater weight in the balance of food security and poverty alleviation in the country.
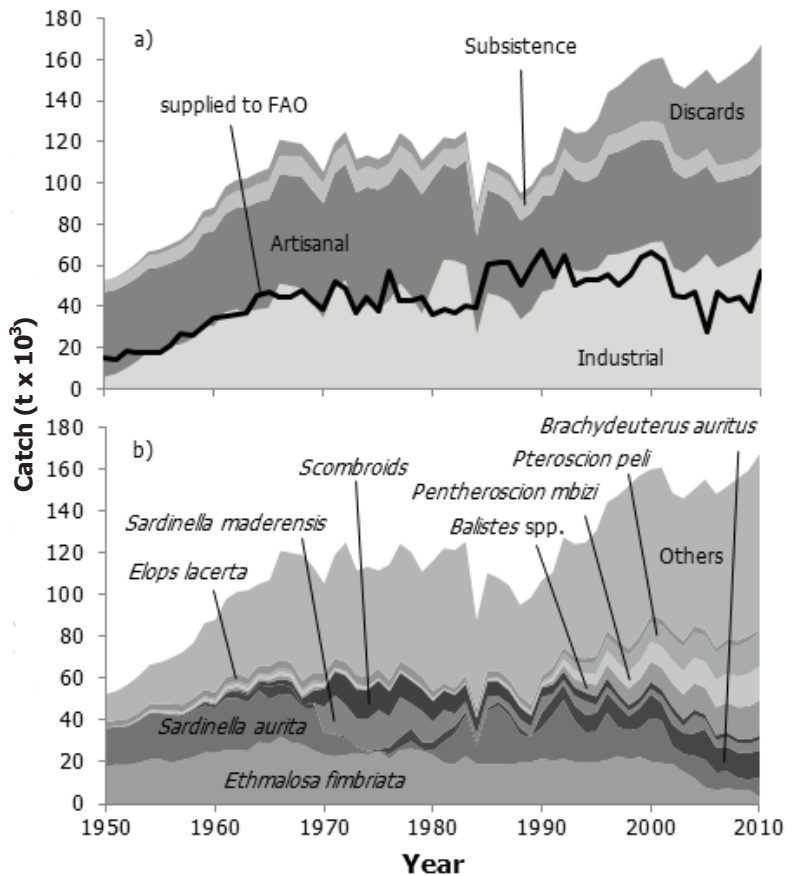
Despite multiple efforts, notably to tackle the issue of the non-reporting of 'faux poissons' (which are now being reported as part of Côte d'Ivoire catches, the objectives of fishery development in Côte d'Ivoire are questionable. First, reporting 'faux poissons' in FAO datasets and using these for fishery analysis masks the declining trend of fisheries and jeopardizes the movement towards sustainable fisheries. Furthermore, to counter the effect of over-exploitation and declining supplies, Ivoirian fisheries planners consider modernizing and/or replacing of aging vessels in order to "increase efficiency", which however, will increase fishing effort on overexploited resources and further reduce catches. Finally, while they assert that they want to increase protein supply for domestic consumption as a first objective, they also plan to promote fish exports (Mabawonku 1990).

The important economic role that fisheries play in Côte d'Ivoire is undisputedly due to the small scale fisheries (Diaby 1996; Golé Bi Golé *et al.* 2005). Yet, while the dependence of small scale communities upon fish increases in the face of conflicts (see UNDP 2011), catches that decline, jeopardizing the livelihoods as poverty increases. We illustrated herein that the opportunity to further develop industrial fisheries is no longer justified. Rather, efforts should be focused on controlling the proliferation of illegally operating fleets and on local-scale management plans at the artisanal level (e.g. Laë 1997).

REFERENCES

Akindes F (1995) Dévaluation et alimentation à Abidjan (Côte d'Ivoire). Les Cahiers de la Recherche Développement 40, ORSTOM, Abidjan. 24-42 p.

Amandé MJ, Ariz J, Chassot E, de Molina AD, Gaertner D, Murua H, Pianet R, Ruiz J and Chavance P (2010) Bycatch of the European purse seine tuna fishery in the Atlantic Ocean for the 2003–2007 period. Aquatic Living Resources 23(04): 353-362.

Amon Kothias J (1986) Analyse des débarquements des thonidés mineurs et poissons porte-épée en Côte d'Ivoire en 1984-1985. Collect. Vol. Sci. Pap. ICCAT 25, ICCAT. 262-264 p.

Anon. (1981) Les écosystèmes côtiers de l'Afrique de l'ouest: lagunes, estuaires et mangroves. Rapport d'un atelier. Dakar, 11-15 juin 1979. UNESCO. 3 p.

Anon. (2007) Côte d'Ivoire: des bateaux de pêches chinois accusés de «pillage». AFP, Abidjan. 1 p.

Atta-Mills J, Alder J and Sumaila UR (2004) The decline of a regional fishing nation: the case of Ghana and West Africa. Natural Resources Forum 28: 13-21.

Badmus I (2009) Even the stones are burning: explaining the ethnic dimensions of the civil war in Côte d'Ivoire. J. Soc. Sci. 18(1): 45-57.

Bayley P (1988) Accounting for effort when comparing tropical fisheries in lakes, river-floodplains, and lagoons. Limnology and Oceanography 33(4): 963-972.

Belhabib D, Subah Y, Broh NT, Jueseah AS, Nipey J, WY B, Copeland D, Zeller D and Pauly D (2013) When 'reality leaves a lot to the imagination': Liberian fisheries from 1950 to 2010. Fisheries Centre Working Paper #2013-06, UBC Fisheries Centre, Vancouver.

Belhabib D, Koutob V, Sall A, Lam VW and Pauly D (2014) Fisheries catch misreporting and its implications: The case of Senegal. Fisheries Research 151: 1-11.

Belhabib D, Koutob V, Zeller D and Pauly D (2015) The marine fisheries of Togo, the 'Heart of West Africa' 1950 to 2010. pp. 37-50. *In*: Belhabib D and Pauly D (eds.), Fisheries catch reconstructions: West Africa Part II, 1950-2010. Fisheries Centre Research Reports 23(3), Vancouver [this volume]

Bikbo-Koffie C (2010) La pêche maritime en Côte-d'Ivoire face à la piraterie halieutique. Les Cahiers d'Outre-Mer 251(Juillet-Septembre 2010): 321-346.

Bouberi D (1981) Statistiques de pêche des sardiniers ivoiriens, année 1981. Arch. Sc. Cent, Rech. Océanogr. Abidjan IX, Centre de Recherche Océanographique d'Abidjan, Abidjan. 13-39 p.

Bouberi D (1984a) Statistiques de pêche des sardiniers ivoiriens, année 1982. Arch. Sc. Cent, Rech. Océanogr. Abidjan X, Centre de Recherche Océanographique d'Abidjan, Abidjan. 1-32 p.

Bouberi D (1984b) Statistiques de pêche des sardiniers ivoiriens, année 1983. Arch. Sc. Cent, Rech. Océanogr. Abidjan X, Centre de Recherche Océanographique d'Abidjan, Abidjan. 1-19 p.

Cavérivière A (1978) La pêche des chalutiers ivoiriens dans les zones FAO 34.3.1 (littoral Cap Vert) et FAO 34.3.3 (Sherbro). . p. 12 In Report of the *Ad Hoc* Working Group on Coastal Demersal Fish Stocks from Mauritania to Liberia, Dakar 14-19 nov. 1977 FAO/CECAF/ECAF Series 78/8 Rome.

Cavérivière A (1979) La pêche industrielle des poissons demersaux en Côte d'Ivoire. Généralités, localisation, homogénéité relative des zones de pêche ivoirienne. Doc. Scient. Centre Rech. Oceanogr. Abidjan X, Centre de Recherches Océanographique d'Abidjan, Abidjan. 43-93 p.

Cavérivière A (1983) Les espèces demersales du plateau continental ivoirien. Biologie et exploitation.Volume II, Universite d'Aix-Marseille II, Marseille. 312 p.

Cavérivière A and Marcille J (1978) La pêche industrielle en Côte d'Ivoire. ORSTOM, Paris. 7 p.

Charles-Dominique C, Ecoutin J and San Gnanmilin A (1980) La pêche artisanale en lagune Aby-Tendo-Ehy (Côte d'Ivoire): premières estimations de la production. Arch. Scient. Centre Rech. Océanogr. Abidjan 6, Centre de Recherche Océanographique d'Abidjan, Abidjan. 1-26 p.

Chavance P, Amon Kothias J, Dewals P, Pianet R, Amandè MJ, De Molina AD and Djoh A (2011) Statistics on tuna surface fishery's bycatch landed in Abidjan, Côte d'Ivoire, for the 1982-2009 Period. Collect. Vol. Sci. Pap. ICCAT 66, ICCAT. 2104-2112 p.

Chenery L (1875) The West coast of Africa, Part II. United States Hydrographic Office 47. Government Printing Office, Washington DC.

CIESIN (2012) National Aggregates of Geospatial Data Collection: Population, Landscape, And Climate Estimates, Version 3 (PLACE III). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). Center for International Earth Science Information Network (CIESIN)/Columbia University. Available at: http://sedac.ciesin.columbia.edu/data/set/nagdc-population-landscape-climate-estimates-v3 [Accessed: 29/04/2013].

Collari A (1986) Development planning for small-scale fisheries in West-Africa: practical technical and socio-economic aspects of fish production and processing.7, Programme for the Integrated Development of Artisanal Fisheries in West Africa, Cotonou. 41 p.

Connolly K, Fall A, Fazio R and Wittman M (2013) Côte d'Ivoire Report 2013. University of Oregon, Eugene, OR. 31 p.

Cormier M (1983) La pêche en Côte d'Ivoire. Mise au point des connaissances et perspectives. Université de Paris X, Nanterre. 135 p.

Coulibaly R (2010) Analyse de la contribution de la pêche à l'économie ivoirienne. The African Capacity Building Foundation, World Bank Institute, Abidjan. 34 p.

Cury P and Roy C (1987) Upwelling et pêche des espèces pélagiques côtières de Côte-d'Ivoire: une approche globale. Oceanologia Acta 10(3): 347-357.

Dabalen A, Kebede E and Saumik P (2012) Causes of Civil War: Micro Level Evidence from Côte d'Ivoire. HiCN Working Paper 118, The Institute of Development Studies at the University of Sussex -, Brighton. 60 p.

Dabalen A and Saumik P (2013) Effect of conflict on dietary energy supply: evidence from Côte d'Ivoire. HiCN Working Paper 156, Households in Conflict Network, The Institute of Development Studies, University of Sussex. 46 p.

Delaunay K (1992) Fanti and Ewe fishermen's migration and settlment in Côte d'Ivoire. MAST 5(2): 96-103.

Diaby S (1996) Economic impact analysis of the Ivorian sardinella fishery. Marine Resource Economics 11(1996): 31-42.

Domingo J (1980) Aspects de l'évolution récente des pêches artisanales en Côte-d'lvoire. Norois: 181-198.

Doucet F, Chauvet C, Gilly B and Meuriot E (1985) Programme d'action de la FAO pour Le'aménagement et le développement des pêches.W/R8692, FAO, Rome. 177 p.

Durand J, Amon Kothias J, Ecoutin J, Gerlotto F, Hie Dare J and Lae R (1978) Statistiques de pêche en lagune Ebrié (Côte d'Ivoire): 1976 et 1977. Doc. Scient. Centre Rech. Océanogr. Abidjan IX, Centre de Recherche Océanographique d'Abidjan, Abidjan. 67-114 p.

Durand J, Dufour P, Guiral D and Zabi S (1994) Environnement et ressources aquatiques de Côte d'Ivoire. Tome II: les milieux lagunaires. ORSTOM, Paris.

Ecoutin J (1983) Evolution récente de la pêche collective en lagune Ebrié. Note à Diffusion Restreinte 1, Centre de Recherche Oceanographique d'Abidjan, Abidjan. 7 p.

Ecoutin J (1992) Dynamique des flottilles en pêche artisanale. L'exemple des sennes tournantes en Côte d'Ivoire. ORSTOM, Paris. 214 p.

EU (2008) Protocol setting out the fishing opportunities and the financial contribution provided for by the Agreement between the European Community and the Republic of Côte d'Ivoire on fishing off the coast of Côte d'Ivoire for the period from 1 July 2007 to 30 June 2013. Official Journal of the European Union 48/46, European Union, Brussels. 18 p.

European Economic Community (1990) Protocol establishing the fishing rights and financial compensation provided for in the Agreement between the European Economic Community and the Republic of Côte d'Ivoire on fishing off the coast of Côte d'Ivoire. European Economic Community, Brussels. Available at: http://eur-lex.europa.eu/Notice.do?val=160570:cs&lang=en&pos=2&phwords=cote%20d%20ivoire~fish*~&checktexte=checkbox [Accessed: 07/01/2014].

European Union (2004) Proposition de Règlement du Conseil relatif à la conclusion du protocole fixant les possibilités de pêche et la contrepartie financière prévues dans l'accord entre la Communauté économique européenne et la République de Côte d'Ivoire concernant la pêche au large de la Côte d'Ivoire, pour la période allant du 1er juillet 2004 au 30 juin 2007. European Union, Brussels. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52004PC0619:FR:HTML [Accessed: 07/01/2014].

FAO (1985) Report of the CECAF Ad Hoc working group on the demersal and shrimp resources of the Central Gulf of Guinea Division (34.3.5). CECAF/ECAF Series 86/36, FAO, Rome. 200 p.

FAO (2008a) Report of the FAO/CECAF Working Group on the assessment of demersal resources – Subgroup South. Freetown, Sierra Leone, 9–18 October 2008. CECAF/ECAF 11/73, FAO, Rome. 311 p.

FAO (2008b) Vue générale du secteur des pêches nationales. La République de Côte d'Ivoire. PROFILS DES PÊCHES ET DE L'AQUACULTURE PAR PAYS FAO, Rome. 43 p.

FAO (2009) Report of the FAO/CECAF Working Group on the assessment of small pelagic fish – Subgroup South CECAF/ECAF Series 12/74, FAO, Accra. 172 p.

FAO CdpplAC-E (1981) Rapport de la 5e session du Groupe de travail de l'évaluation des ressources, Dakar, Senegal, 15-17 Oct. 1980. FAO Rapport sur les pêches 244. FAO, Rome.

Folsom W, Rovinski D and Weidner D (1993) World fishing fleets: an analysis of Distant-water Fleet operations. Past–Present–Future. Volume VI: Western Europe and Canada. NOAA Tech. Memo. NMFS-F/SPO-14. National Oceanic and Atmospheric Administration, Silver Spring, Maryland. 374 p.

Fonteneau A and Marchal E (1970) Récolte, stockage ettraitement des données statistiques relatives à la pêche des sardiniers (filet tournant) en Côte d'Ivoire. Doc. Scient. Centre Rech. Oceanogr. Abidjan 1, Centre de Recherches Océanographiques, Paris. 21-30 p.

Fonteneau A and Troadec J (1969) Récolte, stockage et traitement des données statistiques relatives à la pêche au chalut en Côte d'Ivoire. Document Scientifique Provisoire 38, ORSTOM, Paris. 19 p.

Foster D, Heins D, Kalla M, McKenzie M, O'Neal J, Park R, Phillips R, Prestholdt J, Sirleaf II A and Young L (2009) "Everyone Scattered" Experiences of the Liberian Diaspora. pp. 301-398 In Rights TAfH (ed.), A house with two rooms: final report of the Truth and Reconciliation Commission of Liberia Diaspora ProjectThree (VII).

Garcia S and Fonteneau A (1971) La pêche de la crevette en Côte d'lvoire. Bilan 1969-1970 et perspectïves ORSTOM, Paris. 4 p.

Garcia S and Poinsard F (1989) The Committee for the Eastern Central Atlantic Fisheries (CECAF) and the management of West African resources: critical review and implications of extended jurisdiction. pp. 121-156 In Miles E (ed.), Management of world fisheries: Implications of extended coastal state jurisdiction. The University of Washington Press, Seattle.

Gerlotto F and Stequert B (1978) La pêche maritime artisanale en Afrique de l'ouest. Caractéristiques générales. La Pêche Maritime 1202, Abidjan. 180 p.

Global Witness (2007) Hot chocolate: how cocoa fueled the conflict in Côte d'Ivoire. The Global Witness, Washington DC. 72 p.

Golé Bi, Golé G, Koffi K and Dadi S (2005) Contribution socio-économique de la pêche artisanale en Côte d'Ivoire. FAO-DFID, Abidjan. 49 p.

Hardman-Mountford N (2000) Environmental variability in the Gulf of Guinea Large Marine Ecosystem Physical features, forcing and fisheries. PhD thesis, University of Warwick, Department of Biological Sciences. 233 p.

Hem S (1976) Statistiques de pêche des sardiniers ivoiriens, année 1975. Serie Statistiques 1, Ministère de la recherche scientifique, Abidjan. 65 p.

Kébé M, Njock J and Gallène J (1997) Revue sectorielle de la pêche artisanale maritime et lagunaire en Côte d'Ivoire. Document Technique 110, DIPA, Cotonou. 80 p.

Koffie-Bikpo CY (2012) Côte d'Ivoire, 50 ans d'indépendance : permanence, mutation et, ou, évolution des territoires. l'Harmattan, Paris.

Konan A (1998) Co-management in Aby Lagoon, Côte d'Ivoire. Proceedings of the International Workshop on Fisheries Co-management, Fisheries Project, Aby Lagoon, Abidjan. 36 p.

Kouadio B (2009) From stability to insurgency: the root and proximate causes of the September 2002 civil war in Côte d'Ivoire. FIU Electronic Theses and Dissertations, Florida International University, Miami. 115 p.

Kouame K and Enoh M (2011) Rapport sur la dynamique de la consommation alimentaire en Côte d'Ivoire.3, Michigan State University. 98 p.

Laë R (1992) Les pêcheries artisanales lagunaires ouest-africaines: échantillonnage et dynamique de la ressource et de l'exploitation. MSc thesis, ORSTOM, Université de Bretagne Occidentale, Brest, Paris. 205 p.

Laë R (1997) Does overfishing lead to a decrease in catches and yields? An example of two West African caostal lagoons. Fisheries Management and Ecology 4(1997): 149-167.

Lankester K, Diouf P and Sane K (2001) Fisheries Access in West Africa. The promotion of sustainable and equitable fisheries access agreements. WWF, Saly Portudal, Senegal. 216 p.

Lassarat A (1957) La pêche du thon en Côte d'Ivoire. Science et Pêche 44: 1-6.

Lassarat A (1958) La pêche en Côte d'Ivoire. Revue des Travaux de l'Institut des Pêches Maritimes 21(1): 31-63.

Mabawonku A (1990) The role and effect if subsidies on fisheries development in West Africa (Nigeria, Côte d'Ivoire, The Gambia and Senegal). CECAF/ECAF Series 90/53, FAO, Rome. Available at: http://www.fao.org/docrep/003/U1990E/U1990E00.htm#TOC [Accessed: 09/12/2013].

Manning P (2011) Support to the implementation of the FCWC regional plan of action on IUU fishing. Project ref. N°CU/PE1/SN/11/011. ACPFish II, Brussels. 43 p.

Ménard F, Fonteneau A, Gaertner D, Nordström V, Stequert B and Marchal E (2000) Exploitation of small tunas by a purse-seine fishery with fish aggregating devices and their feeding ecology in an eastern tropical Atlantic ecosystem. ICES Journal of Marine Science 57: 525-530.

Menard F, Hoëpffner J, Nordström V, Joanny T and Konan J (2001) A Database for the industrial trawl fishery of Côte d'Ivoire. Naga, the ICLARM Quaterly 24.

Morric MacLean L (2004) Mediating Ethnic Conflict at the Grassroots: the Role of Local Associational Life in Shaping Political Values in Côte d'Ivoire and Ghana. The Journal of Modern African Studies 42(4): 589-617.

N'Goran Y (1990) Statistiques de pêche en Lagune Aby (Côte d'Ivoire). La pêche à l'épervier (1988). Arch. Sci. Cent. Rech. Oceanogr. XIII, Centre de Recherche Océanographique d'Abidjan, Abidjan. 10 p.

Njock J and Westlund L (2010) Migration, resource management and global change: Experiences from fishing communities in West and Central Afria. Marine Policy 34(2010): 752-760.

Nunoo FKE, Asiedu B, Amador K, Belhabib D, Lam VWY, Sumaila UR and Pauly D (2014) Marine fisheries catches in Ghana: historic reconstruction for 1950 to 2010 and current economic impacts. Reviews in Fisheries Science & Aquaculture 22(4): 274-283.

Oceana (2004) European trawlers are destroying the oceans. Oceana, Brussels. 77 p.

OECD (2000) Review of fisheries in OECD countries. Volume I Policies and summary statistics. Organisation for Economic Co-operation and Development, Paris.

Pauly D, Belhabib D, Blomeyer R, Cheung WWWL, Cisneros-Montemayor AM, Copeland D, Harper S, Lam VWY, Mai Y, Le Manach F, Österblom H, Mok KM, van der Meer L, Sanz A, Shon S, Sumaila UR, Swartz W, Watson R, Zhai Y and Zeller D (2013) China's distant-water fisheries in the 21st century. Fish and Fisheries doi: 10.1111/faf.12032.

Pérez-Ruzafa A and Marcos C (2012) Fisheries in coastal lagoons: An assumed but poorly researched aspect of the ecology and functioning of coastal lagoons. Estuarine, Coastal and Shelf Science 110(0): 15-31.

Pigeaud F (2012) En Côte-d'Ivoire, la criée au désespoir. Liberation Terre 27 Aout 2012.

Postel E (1950) La pêche en Côte d'Ivoire. La Pêche Maritime 870, Abidjan. 180 p.

Rey H (1993) L'économie des pêches maritime ivoiriennes. pp. 551-577 In Le Loeuff P, Marchal E and Amon Kothias J (eds.), Environnement et ressources aquatiques de Côte d'Ivoire. ORSTOM, Paris.

Romagny B, Menard F, Dewals P, Gaertner D and N'Goran Y (2000) Le «faux-poisson» d'Abidjan et la pêche sous DCP derivants dans l'Atlantique tropical Est: circuit de commercialisation et role socio-economique pp. 634-652 In Cayre P, Le Gall J and Taquet M (eds.), Pêche thonière et dispositif de concentration de poissons. Colloque Caraibe-Martinique, Trois-Ilets, 15-19 Octobre 1999. Institut de recherche pour le developpement, Institut français de recherche pour l'exploitation de la mer, Ecole nationale supérièure agronomique de Rennes 38. Editions Quae.

Shep H, Traore F and Konan K (2011) Programme régional de renforcement de la collecte de données statistiques des pêches dans les états membres et de la création d'une base de données régionale de renforcement de collecte de données. Enquête cadre-Côte d'Ivoire. Programme Régional UEMOA–Consortium, Ouagadougou. 19 p.

SIF (2010) Sometimes teaching a man to fish is not enough. Stop Illegal Fishing, London. 5 p.

Troadec J, Barro M and Bouillon P (1969) Pêche au chalut sur la radiale de Grand Bassam (Côte d'Ivoire) (mars 1966–fevrier 1967). Doc. Scient. Prov. Centre Rech. Océanogr. Abidjan 33, Centre de Recherche Océanographique d'Abidjan, Abidjan. 14 p.

Troadec J and Garcia S (1979) Les ressources halieutiques de l'Atlantique Centre-Est. première partie: les ressources du Golf de Guinée de l'Angola à la Mauritanie. FAO Document Technique sur les Pêches 186, FAO, Rome. 172 p.

UNDP (2011) The conflict in Côte d'Ivoire and its effect on West African countries: A perspective from the ground UNDP, New York. 8 p.

Valdmanis R and Akam S (2010) Illegal fishing plunders and strains West Africa. ENVIRONMENT, Freetown. 3 p.

Verdeaux F (1981) L'Aizi Pluriel. Chronique d'une ethnie lagunaire de Côte d'Ivoire. Office de la recherche scientifique et technique outre-mer, Abidjan. 303 p.

Appendix Table A1. FAO landings vs. reconstructed total catch (in tonnes), and catch by sector with discards shown separately, for Côte d'Ivoire, 1950-2010.

Year	FAO landings	Reconstructed total catch	Industrial	Artisanal	Subsistence	Discards
1950	14,600	52,700	5,900	41,200	5,200	356
1951	14,223	54,100	7,200	41,000	5,500	481
1952	18,263	57,300	9,900	40,900	5,700	840
1953	17,902	61,300	13,400	40,700	5,900	1,319
1954	17,535	66,600	18,000	40,500	6,100	1,964
1955	17,412	67,800	18,800	40,400	6,300	2,295
1956	20,847	70,000	21,000	40,200	6,500	2,303
1957	26,521	72,600	21,600	41,800	6,800	2,343
1958	26,174	77,200	24,100	43,300	7,100	2,665
1959	29,780	86,500	30,700	44,800	7,300	3,625
1960	34,123	88,200	30,500	46,400	7,600	3,732
1961	35,283	98,000	37,200	47,900	7,800	5,137
1962	36,427	101,500	38,600	49,300	8,100	5,421
1963	36,729	102,300	37,600	50,800	8,300	5,466
1964	45,386	105,200	38,600	52,300	8,600	5,750
1965	47,197	107,200	39,400	52,800	8,800	6,207
1966	44,535	121,200	51,100	53,300	9,000	7,800
1967	44,545	120,100	50,000	53,700	9,200	7,168
1968	47,819	119,200	48,900	54,500	9,400	6,442
1969	43,117	113,400	41,400	55,200	9,500	7,284
1970	38,948	105,500	34,500	55,700	9,700	5,631
1971	51,714	119,400	48,600	56,100	9,800	4,872
1972	48,436	125,100	52,800	56,600	9,900	5,811
1973	36,667	111,700	38,500	57,100	10,000	6,165
1974	44,555	113,500	40,700	57,500	10,100	5,289
1975	37,524	111,700	38,900	58,000	9,700	5,201
1976	57,043	114,600	42,600	57,100	9,700	5,152
1977	42,921	124,500	51,300	56,600	10,300	6,254
1978	43,169	120,400	45,200	57,500	11,600	6,056
1979	44,078	111,100	36,500	57,900	11,200	5,514
1980	35,707	116,300	50,200	52,100	8,200	5,784
1981	38,249	122,300	62,800	46,400	7,600	5,466
1982	36,932	121,500	62,300	44,700	9,300	5,180
1983	40,110	125,400	60,100	51,100	9,200	5,011
1984	39,778	87,800	26,200	48,300	9,800	3,478
1985	60,636	110,500	46,400	50,300	9,800	4,008
1986	61,152	108,200	45,100	49,500	9,800	3,792
1987	61,718	104,500	42,200	48,800	9,700	3,842
1988	50,602	95,200	33,700	48,100	9,500	3,853
1989	59,767	98,800	38,300	47,300	9,400	3,744
1990	67,057	107,100	47,300	46,600	9,300	3,918
1991	54,813	110,800	48,600	45,900	9,200	7,059
1992	65,109	127,500	62,700	45,100	9,100	10,599
1993	50,244	124,400	57,500	44,400	9,000	13,485
1994	52,496	125,000	56,900	43,700	8,900	15,524
1995	53,306	130,700	58,500	45,100	8,900	18,245
1996	55,793	144,300	65,100	48,900	9,000	21,222
1997	50,349	147,600	65,600	49,900	9,000	23,174
1998	55,587	152,400	67,300	50,900	8,900	25,333
1999	63,524	157,200	69,000	51,900	8,900	27,506
2000	66,031	160,100	71,200	50,300	8,800	29,763
2001	62,055	161,000	71,600	48,800	8,700	31,943
2002	44,969	148,800	58,800	47,400	8,600	34,016
2003	44,407	146,200	56,500	45,900	8,400	35,361
2004	47,344	150,600	60,100	44,400	8,300	37,787
2005	27,615	155,300	65,500	43,000	8,200	38,652
2006	46,769	148,300	58,900	41,500	8,100	39,859
2007	42,965	151,900	61,400	40,100	7,900	42,451
2008	44,818	155,800	64,300	38,700	7,800	45,015
2009	38,119	159,700	67,200	37,300	7,700	47,610
2010	56,889	167,400	73,800	35,900	7,600	50,205

Appendix Table A2. Reconstructed total catch (in tonnes), by major taxa for Côte d'Ivoire, 1950-2010. 'Others' contain 78 additional taxonomic categories.

Year	Ethmalosa fimbriata	Sardinella aurita	Brachydeuterus auritus	Sardinella maderensis	Scombroids	Balistes	Pentheroscion mbizi	Pteroscion peli	Elops lacerta	Others
1950	18,300	18,000	0	0	0	98	79	79	2,640	13,500
1951	18,700	18,300	0	0	0	131	109	109	2,710	14,100
1952	18,700	18,700	0	0	0	223	197	197	2,790	16,500
1953	19,800	20,300	0	0	0	344	316	316	2,860	17,400
1954	21,200	22,400	0	0	0	507	475	475	2,930	18,600
1955	21,300	22,100	0	0	0	591	556	556	3,010	19,700
1956	19,800	23,100	0	0	0	595	557	557	3,080	22,400
1957	21,100	20,600	794	0	0	596	555	555	3,160	25,100
1958	22,300	22,300	856	0	0	677	633	633	3,240	26,500
1959	24,500	22,600	1,740	0	0	918	870	870	3,320	31,600
1960	24,400	21,400	1,531	0	0	945	895	895	3,400	34,700
1961	25,800	24,800	2,481	0	403	1,281	1,227	1,227	3,480	37,300
1962	26,000	24,700	3,300	0	807	1,336	1,279	1,279	3,560	39,200
1963	25,200	23,400	3,114	0	1,210	1,332	1,272	1,272	3,630	41,900
1964	29,600	24,700	2,632	0	1,614	1,388	1,325	1,325	3,710	38,800
1965	28,600	21,500	6,046	0	2,017	1,487	1,421	1,421	3,790	41,000
1966	32,200	20,500	4,668	0	2,420	1,882	1,780	1,780	3,860	52,100
1967	29,400	22,700	3,898	0	2,824	1,714	1,591	1,591	3,930	52,500
1968	28,500	17,600	1,113	0	3,227	1,516	1,387	1,387	4,030	60,400
1969	25,700	20,000	2,551	0	5,959	1,591	1,506	1,506	4,140	50,400
1970	23,500	10,500	349	12,080	8,691	1,062	985	985	4,200	43,100
1971	22,700	10,400	427	18,440	11,423	748	607	607	4,260	49,800
1972	23,300	7,700	1,080	15,020	14,155	828	688	688	4,320	57,300
1973	24,400	2,200	603	13,410	14,155	884	816	816	4,380	50,000
1974	23,400	1,200	623	15,200	14,155	608	525	525	4,430	52,800
1975	25,300	0	887	18,710	14,155	458	393	393	4,420	46,900
1976	21,600	2,400	3,052	14,750	12,115	453	370	370	4,140	55,300
1977	26,000	1,200	4,891	19,110	11,587	530	440	440	4,270	56,100
1978	26,300	3,700	6,238	11,810	11,060	499	433	433	4,550	55,400
1979	25,400	800	3,563	14,790	10,532	468	427	427	4,510	50,200
1980	23,500	2,000	4,214	9,520	10,004	522	421	421	3,340	62,400
1981	19,600	10,200	4,327	10,820	9,476	407	245	245	2,520	64,500
1982	19,100	14,500	3,858	5,750	8,949	362	197	197	2,540	66,000
1983	22,900	19,000	2,169	4,780	8,421	423	260	260	3,410	63,800
1984	19,200	8,000	1,733	4,340	7,893	448	395	395	3,140	42,300
1985	19,000	25,300	1,349	5,520	7,365	577	442	442	3,440	47,100
1986	19,000	28,100	1,922	2,580	6,838	761	618	618	3,360	44,300
1987	18,800	23,600	2,091	3,370	6,310	789	664	664	3,280	44,900
1988	19,700	13,400	3,325	4,110	5,782	790	709	709	3,200	43,400
1989	20,100	12,000	432	4,450	5,254	793	691	691	3,110	51,300
1990	21,700	14,900	7,192	7,370	4,727	875	737	737	3,030	45,900
1991	20,700	21,900	7,730	2,370	4,199	1,901	1,761	1,761	2,950	45,500
1992	21,500	28,300	7,530	1,970	4,199	3,033	2,839	2,839	2,860	52,500
1993	20,200	19,500	7,599	4,420	4,199	3,962	3,792	3,792	2,780	54,100
1994	19,600	14,700	8,562	6,390	4,199	4,704	4,510	4,510	2,690	55,200
1995	19,900	14,700	8,912	3,780	4,199	5,611	5,403	5,403	2,920	59,900
1996	21,000	22,700	9,334	3,080	4,199	6,591	6,352	6,352	3,480	61,200
1997	22,900	13,700	10,747	2,810	2,831	7,363	7,093	7,093	3,420	69,700
1998	21,400	13,800	6,902	2,280	2,831	8,139	7,837	7,837	3,360	78,100
1999	22,400	13,800	9,943	2,050	2,831	8,917	8,583	8,583	3,300	76,900
2000	20,300	20,600	11,584	2,510	3,350	9,698	9,332	9,332	3,230	70,100
2001	19,500	20,500	8,505	3,040	3,350	10,475	10,085	10,085	3,160	72,400
2002	19,100	8,400	10,530	5,260	3,397	11,192	10,839	10,839	3,090	66,200
2003	15,300	8,600	10,053	3,040	3,397	11,766	11,376	11,376	3,020	68,200
2004	12,400	10,600	10,885	8,910	2,312	12,648	12,223	12,223	2,940	65,400
2005	7,700	13,400	14,850	4,650	2,312	12,834	12,422	12,422	2,870	71,900
2006	6,700	8,300	12,126	3,420	2,312	13,370	12,933	12,933	2,500	73,700
2007	7,300	8,300	11,836	4,570	2,312	14,252	13,790	13,790	2,720	73,000
2008	6,600	5,900	12,200	4,450	2,076	15,137	14,648	14,648	2,450	77,800
2009	6,900	4,700	12,754	4,470	2,076	16,021	15,505	15,505	2,570	79,200
2010	3,200	9,600	13,072	4,730	2,076	16,904	16,362	16,362	1,030	84,100