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Big Fishing for Small Fishes: Six Decades of Fisheries in The Gambia, "The Smiling Coast of Africa"

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Big fishing for small fishes:

six decades of fisheries in The Gambia, "the smiling coast of Africa"

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ABSTRACT

The Gambian marine fisheries, although often overlooked, are crucial for the local population, mainly because of the importance of the domestic catches, which are reconstructed here. Despite the relatively small size of The Gambian Exclusive Economic Zone (EEZ), the catch of the legal and illegal foreign fisheries, which are reconstructed herein as well, are very high. The other components of Gambian fisheries, notably subsistence and artisanal catches, as well as discards, were also reconstructed for the period from 1950 to 2010. Total removals from The Gambia were estimated at 6 million t for that same period. Domestic catches, of 2.2 million t, were found to be 2.5 times as high as the landings of 875,700 t reported by FAO on behalf of The Gambia for the 1950-2010 period. The annual reconstructed catch of The Gambia, since 2000, oscillates between 50,000 and 60,000 t·year^{-1}, and despite a massive foreign industrial trawl fishing effort, the species caught in greatest quantities continues to be the bonga shad (*Ethmalosa fimbriata*), a popular species locally important for food security. However, their catches are declining, which, along with droughts and increasing fish prices, further jeopardizes food security in The Gambia.

INTRODUCTION

Bordered on three sides by the Republic of Senegal and in the west by the Atlantic Ocean, The Gambia, a.k.a. 'the Smiling Coast of Africa', almost an anomaly of a country, is one of Africa's smallest coastal states. The particular geography of The Gambia was a result of a long political struggle between Great Britain and France to achieve supremacy in West Africa, when an agreement between the two colonial powers was reached in 1889 to establish the borders of The Gambia. It is only after independence of Senegal from France in 1959 that The Gambia gained independence from Great Britain in 1965 and joined the Commonwealth of Nations. In 1970, The Gambia held its first presidential elections, which most likely sharpened the contrast between The Gambia and the other countries in the region. The sudden change in language, culture, currency, and even tourist profile, while travelling from Senegal is certainly most intriguing (D.B., pers. obs.). The well-built roads of The Gambia and the beautiful natural features of the country, which provide the background for "paradise-like" photos in tourist brochures cannot hide the fact that a third of the population lives below the international poverty line of $1.25 US per day.

The other feature of The Gambia that is of interest here is its recent political history, which was shaped by the same president, re-elected four times since Independence, but against whom a coup was attempted in 1981. The coup failed, mainly due to collaboration between Senegal and The Gambia, but led to the death of several thousand people. The Treaty of Confederation between Senegal and The Gambia, which created the Senegambia Confederation following the 1981 coup attempt, contributed to unifying the armed forces, economies and currencies of the two countries for a period a seven years, after which they went their separate ways.

The Gambia lies almost entirely in the Savannah-Sahelian belt of West Africa, and consists of a strip of land whose width varies from 25 to 50 km on either side of the 480 km long Gambia River (Horemans *et* *al.* 1996). Fisheries resources, both marine and estuarine, of The Gambia were surveyed in the mid-1960s and 2000s, and are abundant enough to contribute much to the socio-economic wellbeing of the country. Indeed, the geographical location of the Gambia in the highly productive upwelling zone of the Atlantic Ocean, a large continental shelf (4,000 km^2), and the flow of nutrient rich waters from the Gambia River, make Gambian fisheries resources particularly productive. Also, the particular shape of The Gambia implies that most Gambians live along the coast or the banks of the Gambia River, thus making fishing part of their lives. This, along with major natural events that have negatively affected agriculture, i.e., floods in the 1950s and droughts in 1962 and in the 1980s (Jaiteh and Sarr 2011), magnify the role of fisheries, albeit only small-scale.

Figure 1. Map of the Gambia showing The Gambia River.

Artisanal fisheries have expanded considerably since the 1950s, but much of the expertise in artisanal fishing in The Gambia was imported from outside, particularly Senegal. Thus, motorized canoes were reportedly introduced in the mid-1960s by a single migrant Senegalese fisher (Mendy 2009). The industrial fisheries are obviously also of foreign origin, and their catches are landed outside of The Gambia, and therefore barely recorded despite legislations requiring that 10% of catches be landed in the country. Thus, the direct impact of these fisheries on food security and the Gambian economy is rather low compared to that of the artisanal fisheries.

Artisanal fisheries catches and effort are estimated through a collection system called the Catch Assessment Survey (CAS), through which six canoes are sampled during six days of each month, and then raised to the national level using a factor that takes into account the number of landing sites along the entire coast (Horemans *et al.* 1996; Anon. 2006a, 2007, 2008, 2009), itself derived from a Frame Survey that assesses fishing effort conducted once a year every five years (Anon. 2006b). The mostly Gambian-flagged (but foreign owned) industrial fisheries are monitored through on-board observers. Catch data for other vessels (notably those from the EU) are then added, assuming that vessels with the same capacity and the same gear would perform similarly (Mendy 2004). According to Mendy (2002), the first statistical system was designed and put in place in 1976. Prior to this, reports of fish landings were only made out of curiosity by people visiting outside the capital of Banjul. The data collected through these systems posed certain concerns regarding the extent in which it covers the Gambian coast, and the validation process of the data (Lazar and Somers 2011). While artisanal catch data produced are believed to be dubious and sometimes outdated (Horemans *et al.* 1996; Lazar and Somers 2011), the industrial catch data remain even less reliable, given the low salaries paid to on-board observers, which may render them susceptible to bribery.

As a result, official fisheries catch data tend to underestimate catches, and thus fail to document the crucial contribution of fisheries to Gambian food security. Indeed, The Gambia being classified as one of African countries that is most dependent upon fish, one can hardly believe that only 20 kg·$capita^{-1}$ are consumed annually (Allison *et al.* 2009). Thus, there is an urgent need to reassess Gambian fisheries catches, by adding unreported components such as subsistence fisheries, as well as illegal catches by industrial vessels, among other things.

METHODS

Official landing data was extracted from FAO FishStat (1950-2010), from which freshwater species were removed and then compared to data provided by the Department of Fisheries (Mendy, unpub. data) for the period between 1985 and 2009, which provide landings for the artisanal and industrial sector. The comparison shows that the data supplied by the Government of The Gambia is higher, overall, than the data extracted from FAO FishStat (Figure 2). However, the artisanal landing data provided by the government of The Gambia matched the data supplied by FAO between 1991 and 2006 (excluding 2003). Thus the difference between the two dataset is most likely due to the fact that a portion of the industrial national landings includes foreign catches. Therefore, we used the FAO data as the reported landings baseline for The Gambia.

While reviewing the literature on Gambian fisheries, we noted that catches of small pelagic fishes taken off The Gambia were often lumped with Senegalese catches. Also, in the past, an exceeding amount of attention was given to the (marine) artisanal catches of sardinellas (*Sardinella* spp.) and bonga shad *Ethmalosa fimbriata* (see e.g., Scheffers and Conand 1976; Troadec and Garcia 1980), while other fishes, caught in the Gambia River, were ignored. Here, we re-estimate artisanal catches, as well as industrial catches, both domestic and foreign, along with discards and a large non-commercial component that includes subsistence and recreational fisheries. However, we only estimate catches taken in the marine waters of The Gambia, and do not address the freshwater fisheries.

Note that catches from the Gambia River (or more precisely from the Gambia River *estuary*) are only included here if they consist of marine or brackishwater fish and invertebrates, i.e., freshwater species are excluded.

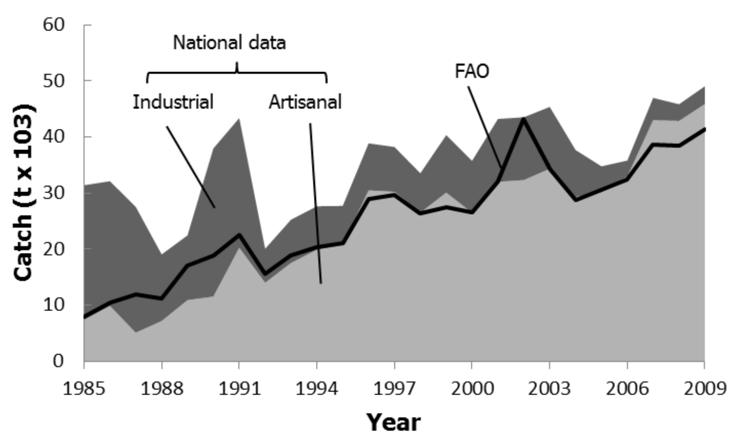

Figure 2. Comparison between catch data extracted from FAO FishStat database and data held by the Government of The Gambia, 1985-2009.

Artisanal

Artisanal fisheries in The Gambia operate both off the Atlantic coast of The Gambia and along the Gambia River, and are thus highly diverse (Mendy 2009). Artisanal fisheries data, both on landings and the number of canoes were made available through surveys since the beginning of the 1980s. Artisanal landings documented by the CAS included largely the marine (Atlantic) component between 1981 and 1992, then expanded to include both marine (Atlantic) and river[1] components since then (Anon. 2006a,

[1] Recall that Gambia River catches include mostly marine and estuarine species as the lower Gambia River is actually a long estuary.

2008). To complete the artisanal catch time series, we first estimated a time series for the catch per unit of effort (CPUE). A CPUE of 269 kg·boat^{-1}·trip^{-1} for 1994 was estimated as the mean of values for two landing sites of The Gambia (Horemans *et al.* 1996). We assumed that the CPUE was 20% higher in 1950 (323 kg·boat^{-1}·trip^{-1}) compared to the 1994 CPUE due to over-exploitation, and only 20% lower in 2000 (215 kg·boat^{-1}·trip^{-1}), this low estimate meant to consider the effect of the drastic decrease in industrial fishing effort since the mid-1990s. We interpolated linearly between these CPUE estimates to fill in the gaps. We then followed a series of steps:

<u>For the marine component:</u>

(1) For the period between 2006 and 2009, we assumed that the data provided by the government of The Gambia through CAS were valid, and also assumed 2010 catches to be the same as in 2009;

(2) For 1992, artisanal marine landings were estimated at 10,783 t (Mbenga 1996) out of a total of 14,035 t (Anon. 2006a), i.e., 77%. We applied this percentage to the total artisanal landings provided by the government of The Gambia (2008) to estimate the marine component of artisanal landings between 1993 and 2005;

(3) For the period between 1981 and 1992, we used the data on artisanal landings provided by the government of The Gambia, which only included the marine component;

(4) For 1980, we multiplied the number of canoes operating along the Atlantic coast by the CPUE for 1980 (286 kg·boat^{-1}·days^{-1}), then by the number of days spent fishing for the canoes operating on the Atlantic coast, conservatively cumulated to five months per year, i.e. 150 days . The total number of canoes was estimated at 712 (Lesack and Drammeh 1980), of which around 290 were operating in The Gambia River and 422 were operating on the Atlantic coast. Thus, the marine catch was estimated to be 18,111 t·year^{-1} for the 1980s;

(5) We repeated step (4) for 1974 and 1965 for a number of canoes estimated at 350 and 214, respectively (Everett 1976), and a CPUE of 294 kg·boat^{-1}·day^{-1} for 1974 and 304 kg·boat^{-1}·day^{-1} for 1965 using the same number of fishing days, 150 days. Catches were estimated at 15,406 t·year^{-1} for 1974 and 9,773 t·year^{-1} for 1965;

(6) We extrapolated the trend drawn by catches estimated in (4) and (5) backwards and estimated a marine catch of 2,688 t for 1950, and then interpolated linearly to fill in the gaps;

<u>For the Gambia River component, we:</u>

(7) Repeated step (1) between 2006 and 2010 for the river component;

(8) Estimated river landings as the difference between the total artisanal landing data and the marine component estimated in step (2) between 1992 and 2005;

(9) Multiplied the number of boats operating in the river in 1980 (Lesack and Drammeh 1980), i.e., 290 canoes, by an interpolated CPUE of 286.1 kg·boat^{-1}·trip^{-1} and 50 fishing trips (Government of The Gambia 2007), and estimated river catches at 6,037 t·year^{-1} for 1980. River catches were then the equivalent of 33% of artisanal catches;

(10) Applied the rate estimated in (9), i.e., 33% to artisanal catches and estimated river catches at 5,135 t for 1974, and 3,258 t for 1965; and

(11) Repeated step (6) for the Gambia River catch component for 1950 to 1964.

For inference on the species composition of the catch, we used data from CAS (Mendy, unpubl. data), and assumed that the taxonomic breakdown provided for 1992 (which included marine and river catches) applied to total artisanal catches prior to 1981.

Subsistence catches

Although farming was (and still is) the predominant occupation of most Gambians, member of rural communities have been fishing for subsistence using fishing gears such as traps, cast nets, etc. (Madge 1994; Mendy 2009). In response to the Economic Recovery Programme (ERP) implemented in 1985, which liberalized pricing systems, subsistence activities, previously undertaken to satisfy personal and family consumption, became a way of obtaining cash (Madge 1994). Along with shellfish collection (mostly by women), and the fish women receive for helping men with their fishing activities, line and net fishing are operated by men (Madge 1994). Crab fishing and gathering and fishing from the river banks are also important subsistence activities, and are conducted mainly by children (Madge 1994). Therefore, we estimated three components of subsistence fishing: the first component estimates shellfish catches collected by women; the second component is the fish donated by pirogue owners to women helping with fishing activities; and the third component estimates catches from riverbanks by men and children.

Shellfish collection

As in Senegal, subsistence fishing consists, to a large extent, of oyster and cockle gathering, for example in the Tanbi Wetlands, which was declared a National Park and Ramsar site in 2007, but has hosted these activities for decades. However, shellfish gathering, which is performed by women is conducted all along other estuarine and mangrove areas of the Gambia River and its tributaries ('bolongs'). This well-known fishery is not monitored, and is excluded from the frame survey (Anon. 2012). Indeed, all land-based fishing techniques are excluded from the CAS.

These fisheries are not solely for personal consumption, since a large part of the collected shellfish is sold. However, since most of these are meant to improve household livelihood, we consider these as subsistence. We note, though, the recent microcredits scheme developed by the USAID-funded Baa Naafa Project, which aims to develop this fishery into becoming artisanal.

A survey covering the entire Tanbi National Park area, estimated an average of 42 fishers per village in 2012, 30 fishers per village in 2002, and 10 fishers per village in 1982 (Anon. 2012), with the earlier figures obtained via questionnaires. We extrapolated these figures backwards, and estimated 1.9 fishers per village on average in 1950, and 3.43 for 1962, which we increased by 30% to account for the increase in the coastal population caused by the 1962 drought. Since the sample provided by Anon. (2012) covers the entire Tanbi National Park and gives a realistic retrospective of the other mangroves of The Gambia, we assumed these numbers apply in a similar way to villages located near other mangroves along the River Gambia, notably the 8 mangroves in Njie and Drammeh (2011). We therefore used Google Earth to count the villages around these mangroves, and counted 75 within a range similar to that of the villages surrounding Tanbi National Park. We assumed the number of villages remained constant between 1950 and 2012. We then multiplied the number of fishers per village estimated previously for 1950, 1962, 1980, 2002 and 2012 by the total number of villages and estimated total number of fishers for these years (Table 1).

Catches were estimated in terms of number of buckets of shellfish at 2 buckets·fisher^{-1}·trip^{-1} for 2012, 3.5 buckets·fisher^{-1}·trip^{-1} for 2002 and 7 buckets·fisher^{-1}·trip^{-1} for 1982 (Anon. 2012). This declining trend reflects the over-exploitation status of these fisheries where *"[t]he harvest grounds used to be within close range during the 1950s to the 1970s. However, increased entry and harvesting intensity has compelled harvesters to now travel longer distance by canoe in search of less exploited oyster sites"* (Njie and Drammeh 2011). The same authors observed a catch of processed , i.e., smoked shellfish of 2.567 kg·fisher^{-1}·trip^{-1}, which when multiplied by the FAO wet weight conversion factor of 4.5, resulted in a wet weight CPUE of 11.55 kg·fisher^{-1}·trip^{-1} for 2011 (assumed constant from 2010 to 2012). Considering two buckets per trip, the volume of catches contained in each bucket is averaged at 5.78 kg of shellfish per bucket. We multiplied the latter by the number of buckets per year, assuming a constant volume for each bucket, and estimated the catch per trip for 2002, 1982 and extrapolated backwards to estimate the catch per trip for 1962 (year of the drought) and 1950 (Table 1). Shellfish gathering lasts 2 days, the third day is for processing, which represents a cycle of three days (Crow and Carney 2012). Knowing that shellfish collecting lasts 7 months (Anon. 2012), excluding around four days per month (Sundays), the number of active days is 182, which correspond to 60.7 cycles of two fishing days each and one processing day, meaning 120 days fishing. Thus, we obtained shellfish catches by multiplying the CPUE by the number of fishers and the number of fishing days.

Taxonomically, Niang (2008) described catches as including 31% volutes (Gastropoda; *Cymbium* spp.), 27% arks (*Anadara* spp.), 20% oysters (*Ostrea* spp.), 12 % *Melongena* spp. and 12% murex (*Bolinus brandaris*).

Table 1. Number of fishers anchor points and corresponding CPUE.

Year	Fishers	Baskets per fisher	Catch per trip ($kg \cdot trip^{-1} \cdot fisher^{-1}$)
1950	143	-	77.4
1962	335	-	63.8
1982	750	7.00	40.4
2002	2,250	3.50	20.2
2012	3,150	2.00	11.6

Fish received by women as a payment for helping fishers

Madge (1994) performed a household survey and estimated that, in 1988, non-traded sea fish was consumed on 141 occasions per household of 16.25 people on average. Assuming 1 $kg \cdot household^{-1}$ at each occasion, 8.67 $kg \cdot capita^{-1}$ consumed annually comes from such fishing activities. Given increasing prices of fish (Njie 2007), we assumed this quantity was 20% higher in 1950, and 50% lower in 2010, and interpolated linearly to fill in the time series for the intervening years (Table 2). A household in The Gambia includes 11.6 members today (Jaimovich 2011), in contrast to 16.25 in 1988 (Madge 1994). We assumed the size of the household was constant between 1950 and 1988, and interpolated linearly between 1988 and 2011 to fill in the data for the intervening years.

Assuming one woman helps with one canoe on average, which is highly conservative, we multiplied the number of canoes (Table 2) by the number of people supported by these women in each household, and then by the consumption rate per capita, assuming the number of canoes was constant between 1950 and 1964.

Table 2. Estimation of fish catches offered to women for helping fishers in The Gambia, with interpolated data in italics.

Year	Canoes	Reference	Annual consumption ($kg \cdot capita^{-1}$)	Household size
1950	-	-	10.40	16.25
1965	214	Everett (1976)	*9.72*	16.25
1974	350	Everett (1976)	*9.31*	16.25
1980	712	Lesack and Drammeh (1980)	*9.04*	16.25
1983	1,299	Anon. (2006b)	*8.90*	16.25
1985	1,419	Mbenga (1996)	*8.81*	16.25
1986	1,302	Mbenga (1996)	*8.76*	16.25
1987	1,673	Mbenga (1996)	*8.72*	16.25
1988	1,517	Mbenga (1996)	8.67	16.25
1990	2,175	Mbenga (1996)	*8.31*	*15.85*
1992	2,407	Mbenga (1996)	*7.95*	*15.44*
1994	1,653	Horemans *et al.* (1996)	*7.59*	*15.04*
1997	1,785	Mendy (2002)	*7.04*	*14.43*
2000	2,053	Mendy (2002)	*6.50*	*13.82*
2006	1,707	Anon. (2006b)	*5.42*	*12.61*
2010	1,707	Assumed	4.70	*11.80*

Subsistence catches by men and children

Around 6% of each household along the coast of The Gambia engage in fisheries (Jaimovich 2011). To estimate catches by men and children, we used the previous per capita catch estimate (Table 2) multiplied by the coastal population. We extracted the total population from Populstat (www.populstat.info [2013]) for 1950, and from The WorldBank database between 1960 and 2010, and interpolated to fill in the gaps. We estimated the coastal population of The Gambia using the coastal population rate provided by CIESN (2013), where around a quarter of the population lives on the coast (26.4%). Given the relatively low change in this rate between 1990 and 2010, we kept it constant for the entire time period, and multiplied it by the total population of The Gambia (Figure 2). We then multiplied per capita fish consumption estimated earlier (see Table 2) by the coastal population to obtain the subsistence catches by men and children (after subtraction of the catches generated by women to avoid double-counting).

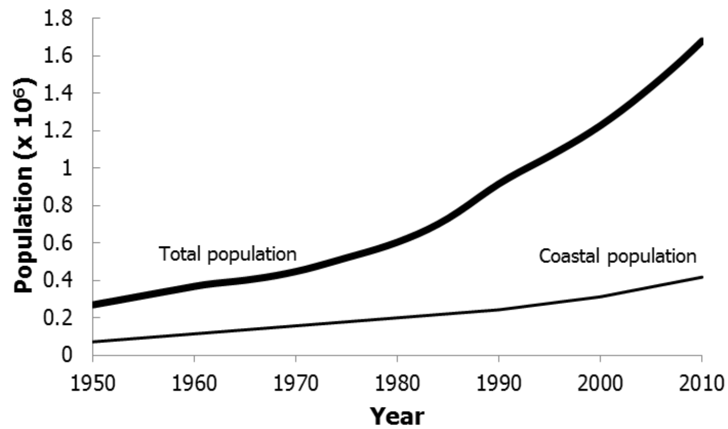

Figure 2. Total and coastal population of The Gambia, 1950-2010.

Recreational catches

Recreational fishing in The Gambia is conducted by foreign tourists, mostly through the numerous tour agencies based in The Gambia and in Europe. The first tourist flight arrived in The Gambia from Sweden in 1965 (Mendy 2008). The number of tourists (recreational visitors) was reconstructed using anchor points between 1965 and 2010 (Table 3). We completed the time series by applying a series of linear interpolations. We assumed 4.3% of the total number of recreational visitors were recreational fishers (Manel 2008), spending on average 10 days in The Gambia and fishing during 5 days[2]. We assumed the number of visitors in 1981 was half the number of visitors in 1980 to account for the political events that will have discouraged foreign tourism and recreational activities along with other economic difficulties encountered by the sector during that year (Jabara 1990). The same author illustrated how tourism has grown fast since then. To estimate the CPUE of recreational fishers, we combined observations from six YouTube videos posted by tourists and recreational fishing companies in The Gambia with photos of fish catches and their weight provided by www.african-angling.co.uk [2013] between 2008 and 2010. Overall, 54 observations were collected for 63 tourists. The weighted average CPUE was estimated at 14.5 $kg \cdot tourist^{-1} \cdot day^{-1}$. We assumed this CPUE was constant in the 2000s, and was 20% higher in 1965, i.e., 17.4 $kg \cdot tourist^{-1} \cdot day^{-1}$, due to the generalized over-exploitation pattern in the Senegambia region in more recent times. We then interpolated linearly to complete the estimate. We multiplied the CPUE by the number of fishers, then by the number of fishing days and obtained total recreational catches in The Gambia. Finally, we applied the taxonomic breakdown derived from the previous observations.

[2] http://www.african-angling.co.uk/latest_gambia_fish_catches_Mar_April_May_2010.htm [Accessed on September 20, 2013]

Table 3. Taxonomic breakdown of recreational catches for The Gambia.

Common name	Scientific name	Observed weight (kg)	%
Barracuda	*Sphyraena* spp.	399.2	44
Stingray	*Dasyatis* spp.	152.9	17
Captainfish	*Dasyatis marginata*	139.1	15
Cassava	*Chloroscombrus chrysurus*	42.6	5
Pompano	*Alectis alexandrinus*	34.0	4
Red snapper	*Lutjanus* spp.	29.5	3
Misc. fish	-	27.2	3
Sompat	*Pomadasys jubelini*	20.4	2
Blue butterfish	*Stromateus fiatola*	13.6	1
Guitarrefish	*Rhinobatos* spp.	13.6	1
Tarpon	*Megalops atlanticus*	11.3	1
Yellowtail	*Seriola* spp.	9.1	1
West African ladyfish	*Elops lacerta*	6.8	1
Groupers	*Epinephelus* spp.	13.6	1

Industrial catches

Industrial catches in The Gambia are generated mostly by foreign vessels which do not land any of their catch for further processing and marketing in The Gambia. Rather, transhipping at sea is used on a grand scale, in spite of the legislation requesting vessels to land 10% of their catches in The Gambia or to pay the cash equivalent of the 10% to the Government of The Gambia (Mendy 2002).

The industrial fishery has the capital city of Banjul as its hub. Prior to the start of a Vessel Observer Programme, in 1991, catch data from industrial fishing vessels were reported by vessel owners, which will have resulted in under-reporting. Since 1991, all fishing vessels operating in The Gambia are mandated to take an observer on-board, to collect catch and effort data together with positions of fishing operations. These data are then reported daily by radio to the Monitoring, Control and Surveillance (MCS) unit based at the Fisheries Department in Banjul. The department of fisheries complete the missing data for other vessels by assuming vessels with the same capacity (e.g., GRT) perform similarly (Mendy 2009). The literature repeatedly addressed issues regarding this data collection system, one of them being that observers were paid by vessel owners, and another the willingness of vessel owners to have observers on-board, a requirement which is not always met (Horemans *et al.* 1996). Under the EU/Gambia and the Gambia/Japan fishing agreements for example, industrial fishing vessels did not take observers on-board but were required to forward statistical reports to the Fisheries Department. However, since the presence of observers on-board the Gambian fleet is required, we may conservatively assume that catches are reported in a more reliable manner for the foreign-owned but domestically reflagged and the few vessels belonging to the domestic industrial fleet, but with a tendency to under-report for the foreign fleets. We performed a reconstruction of 'domestic' industrial catches to test whether the hypothesis of reliable reporting for 'domestic' vessels was realistic.

A comprehensive list of fishing vessel names, Call Sign, Registration Number, Licence Number, period of validity, flag (interchangeably referred to as 'nationality' and 'flag'), vessel gear type, engine power, company, and the reported GRT between 1998 and 2013 was provided to us by the MCS Unit of the Gambian Department of Fisheries during a short visit to Banjul Herein, we used the same method as the Department of Fisheries, i.e., we assumed vessels with similar GRT will have similar catches on average. This means the daily CPUE per unit of GRT will be consistent throughout the fleet.

We suspected that when fishing vessels pay licence fees based on the GRT of the vessel, vessels may under-report GRT. Therefore, we investigated the real GRT of vessels by entering either the name of the vessel or the call sign (when these were consistent) into online databases such as www.grosstonnage.com [2013] and www.vessel-finder.com [2013] which documented the GRT, the history of reflagging, and the residence of the owner and/or management company. For example, a vessel which had previously been reflagged to Honduras, Panama and Belize, all known to be Flag of Convenience (FoC) countries which have lower standards of regulations, health and safety requirements of the crew, taxation etc. (see Miller and Sumaila *In press*), and for which the managing company is based in Las Palmas, would be treated as Spanish. Then, the average real GRT per country of origin (or beneficial ownership) was estimated.

The number of vessels and the GRT between 1985 and 1992 was obtained from Beaudry *et al.* (1993) by dividing the total number of vessels by the number of years for each country. For China, Italy, Nigeria, Russia, St. Vincent, UK, Brazil, Ukraine, Latvia, Morocco, Portugal and USA, for which the number of vessel was too small, we kept the number of vessels per year as the total provided by the authors. Similarly, for Ghana, the number of vessels was kept as is between 1971, when the agreement began (Weber and Durand 1986) and 1990, when the agreement ceased. For Norway, Bermuda and South Africa, Everett (1976) documented 8 purse-seiners, which caught 14,000 $t \cdot year^{-1}$ (assumed to be a third each). We also interpolated the number of vessels from zero the year preceding the first fishing agreement with Senegal (1968, Weber and Durand 1986; Ndiaye 2011), Russia (1975, Weber and Durand 1986), Korea (1976, Weber and Durand 1986), and China[3] (1983). The GRT between 1985 and 1992 was obtained by dividing the total GRT registered by the total number of vessels (Beaudry *et al.* 1993). We kept the GRT constant between 1950 and 1992, and then we interpolated to the first real GRT point between 1998 and 2013 for each country. Thus, we obtained a time series of the number of boats and the profile of their GRT based on their country of origin.

CPUE estimates were derived from catch and effort data from Senegambia (Caverivière and Rabarison Andriamirado 1988) and Senegal (Belhabib *et al. In press*). Although past CPUE estimates for The Gambia seemed to be higher than those for Senegal (33-37%) for trawlers (Lhomme *et al.* 1975), this might not be reflected in other gears. Thus, we believe that using an average CPUE estimated by a comprehensive model that takes into account different gears (see Belhabib *et al. In press*) is more appropriate because it will lead to a conservative estimate. Thus, the CPUE was estimated at 20.2 $kg \cdot GRT^{-1} \cdot day^{-1}$ between 1988 and 1990 using Caverivière and Rabarison Andriamirado (1988), at 14.78 $kg \cdot GRT^{-1} \cdot day^{-1}$ for the 2000s, and was assumed to be 20% higher in 1950 relatively to 1988 (Belhabib *et al. In press*). We interpolated linearly to complete the time series.

In the past, foreign fleets were operating in Senegal and The Gambia during the same licensing period (Lhomme *et al.* 1975; Caverivière and Rabarison Andriamirado 1988). The number of fishing days of a trawler operating in The Gambia represented 41% of the number of fishing days in Senegal by the same trawler (Lhomme *et al.* 1975). Therefore, we assumed that the number of fishing days between 1968 and 1971 (a period covered by the previous study), was equivalent to 41% of the number of fishing days reconstructed by Belhabib *et al.* (*In press*) for Senegal, i.e., 64.1 days per year. We then interpolated linearly to 165 days in 2000, which was kept constant between 2000 and 2010. For domestic trawl and purse-seine fleets and the Ghanaian purse-seine fleet based in The Gambia, we assumed the number of days was constant over time at 165 days, as they were likely to operate in The Gambia only. For Japanese tuna vessels, we assumed the number of fishing days was around 50% of the recorded licence period, which is the average duration of operation by licence period in Mbye (2005), i.e., 90 days.

We used the same species breakdown provided by Mendy (unpubl. data) documenting industrial catches by taxon between 1985 and 2010. We assumed this breakdown remained unchanged between 1968, at the beginning of industrial fishing, and 1985. We applied this breakdown to all industrial catches excluding Ghana, Norway, Bermuda, South Africa and Japan. For Ghana, 13,000 $t \cdot year^{-1}$ consisted of sardinellas and bonga shad (Freon *et al.* 1978); the remaining was allocated to "marine fishes nei". Similarly, we assumed all catches by Norway, Bermuda and South Africa were cluepoids, as these were operating small pelagic purse-seiners. For Japan, we assumed all catches were scombrids, i.e., tuna.

[3] http://www.sinoafrica.org/en/node/883 [Accessed on 23/09/2013].

Illegal and unregulated fisheries catches

Bours (2004) stated that over 34% of sighted vessels during an aerial survey were not identifiable, which shows that these vessels do not comply with FAO guidelines. Illegal catches were estimated to be 12% of legal catches in 2010 (Agnew *et al.* 2010). The level of monitoring, control and surveillance increased in recent decades, and thus the level of sighted illegal activities decreased by 9% between 1996 and 2000, and by 2% between 2000 and 2001 (Agnew *et al.* 2010). We extrapolated this rate of change backwards and forwards, and then derived the rate of illegal fishing between 1950[4] and 2010 from the initial anchor point (12% in 2010) by multiplying this rate by the estimated annual rate of change. We then multiplied the estimated illegal fishing rates by the reconstructed industrial catch. The Gambia declared its EEZ in 1982; thus, prior to 1982, all catches estimated herein are considered unregulated rather than illegal. Illegal and unregulated catches were assumed to be Russian (former USSR) between 1968 and 1982 to reflect upon the high presence of Russian vessels in neighbouring Senegal (Belhabib *et al. In press*), and then Chinese since China was the only country documented to be illegally fishing in The Gambia (Dobo 2009; Pauly *et al.* 2013).

Discards

Discards were included in the official national statistics for the years 1998, 2000, 2004, 2008, and 2009 for the reported domestic industrial catches as a rate of 3% to 15% (Mendy, unpubl. data). We extrapolated the trend backwards and estimated a discard rate of 32% when trawling began in The Gambia in 1968. We interpolated linearly between 32% in 1968 to 9.3% in 1998 (reported by observers on-board Gambian vessels), and then to 15% in 2000, 12.2% in 2004, 2.6% in 2007 and 2.8% in 2009, keeping this rate constant to 2010. We multiplied these rates by the total industrial 'domestic' reflagged catch.

The profile of trawl discards of foreign fleets is similar to that of Senegal (see Belhabib *et al. In press*), with much higher unreported discards (Anon. 1979). We therefore applied discard rates reconstructed by Belhabib *et al.* (*In press*) to the estimated demersal catches. These discard rates are declining, which is further illustrated by the new cooperation developed between artisanal fishers and industrial vessels, exchanging discards for commodities (Mbye 2005). Since Japan operated tuna vessels, and Norway, Ghana, Bermuda and South Africa caught small pelagic species, these countries' catches were excluded from the estimation of discards.

RESULTS

Artisanal

Artisanal catches were estimated at 1.2 million t between 1950 and 2010, of which 76% were taken from marine waters (Figure 3a). Artisanal catches increased from 3,600 t·year^{-1} in 1950 to 24,000 t·year^{-1} in 1980, right before the 1981 coup attempt. Artisanal marine catches declined rapidly thereafter to around 11,300 t·year^{-1} in 1982, subsequently increasing again, along with the increase in the number of canoes to 45,600 t·year^{-1} in 2010 (Figure 3a). Taxonomically, bonga shad constitutes the bulk of artisanal catches. The contribution of bonga shad to artisanal catches declined in recent years, but were slowly but increasingly compensated by catches of sardinellas and catfishes (Family Ariidae), while shark and ray catches increased between the late 1990s and the early 2000s, at the time when shark finning in North West Africa drove their populations down, followed by an inevitable decline of the catch to 2010 (Figure 3b).

[4] Here we treat the 200 nm waters for years prior to declaration of the EEZ as EEZ-equivalent waters of The Gambia.

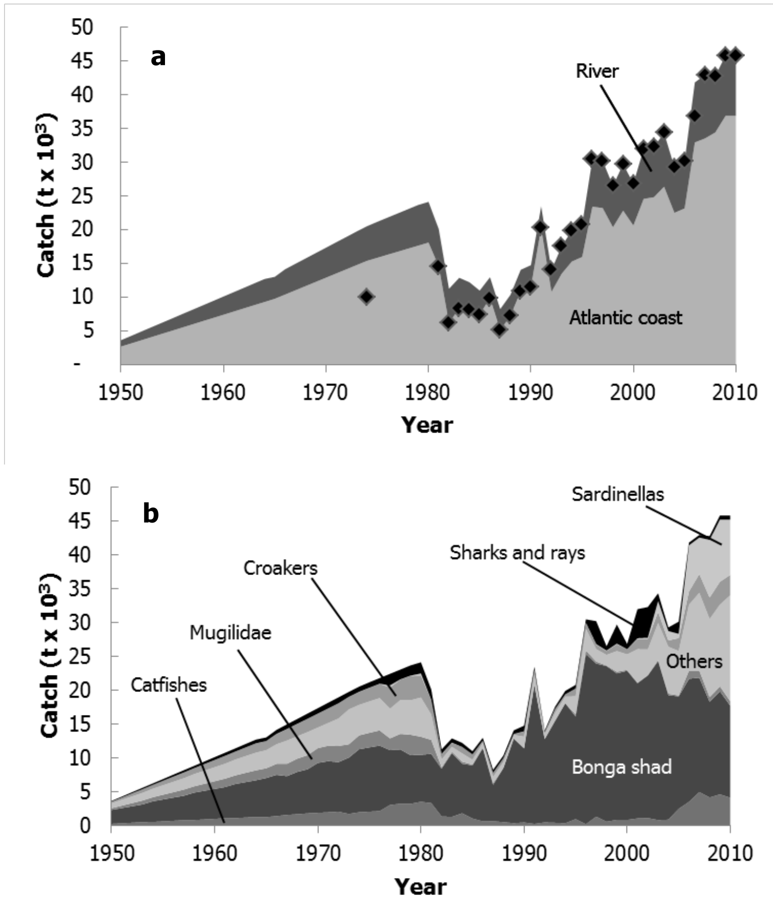

Figure 3. Reconstructed artisanal catches for The Gambia by (a) segment compared to national data (black diamonds), and (b) by taxon, 1950-2010.

Subsistence catches

Subsistence catches were estimated at 320,000 t between 1950 and 2010, of which 69% were caught by women, 29% were caught by men and children and 2% were caught by adult male artisanal fishers and offered to women as a payment for helping with fishing activities (Figure 4). Subsistence catches increased from around 2,000 $t \cdot year^{-1}$ in 1950 to a peak of 7,500 $t \cdot year^{-1}$ in 2002 (Figure 4), likely driven by the increase in shellfish catches caused by new microcredits offered to women for their fishing activities.

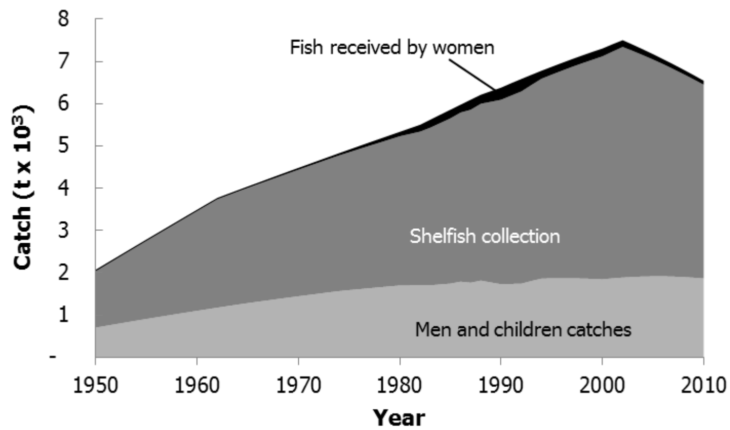

Figure 4. Reconstructed subsistence catches for The Gambia, 1950-2010.

Recreational catches

Recreational catches, mostly barracudas and stingrays, increased from very low rates in the mid-1960s to around 250 t·year^{-1} in the mid-1980s, then fluctuated to reach a peak of 460 t·year^{-1} in 2008, driven by the high number of tourists (Figure 5).

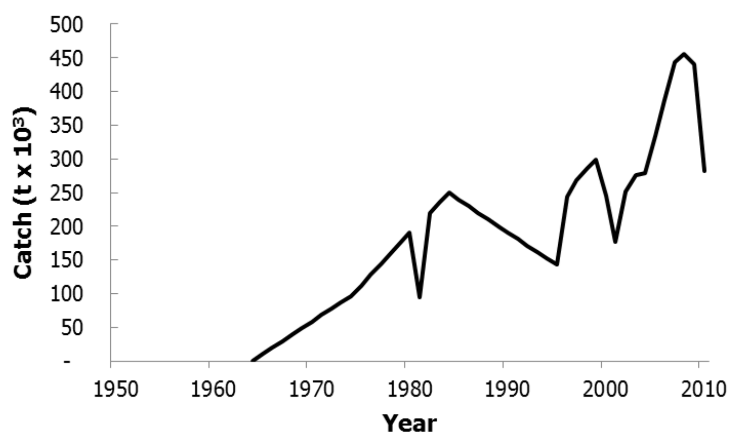

Figure 5. Reconstructed recreational catches in The Gambia, 1950-2010.

Industrial catches

Total industrial catches were estimated at 2.8 million t between 1967, when industrial fishing was introduced to The Gambia by a British company, and 2010, the bulk of which (80%) was foreign. Total industrial catches increased from less than 700 t·year^{-1} in 1967 to a peak of around 166,000 t·year^{-1} when the presence of the EU fleets was at its maximum under The Gambia/EU fishing agreements (Figure 6). Thereafter, catches declined sharply, driven mostly by the decline in the number of fishing vessels, to around 18,000 t·year^{-1} in 2010, of which less than 2,000 t·year^{-1} were 'domestic' (Figure 6).

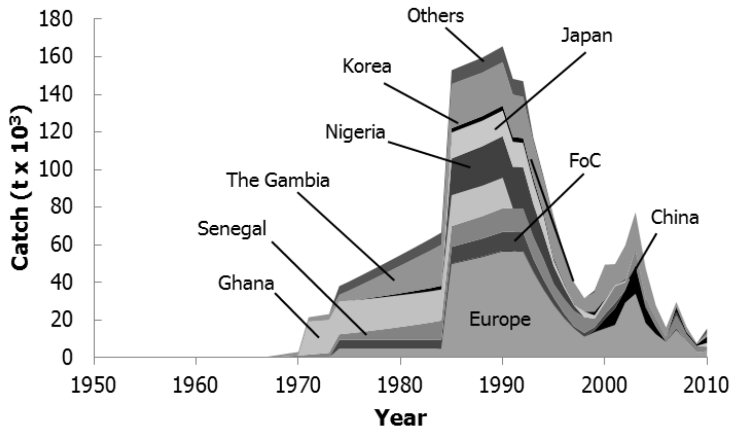

Figure 6. Reconstructed industrial catches from The Gambia, 1950-2010. This figure does not present discards and illegal catches; 'FoC' refers to flags of convenience (see text).

Domestic industrial catches

Domestic industrial catches were estimated at 570,000 t between 1967 and 2010, of which at least 20,000 t were caught by foreign vessels reflagged to The Gambia during the 1998-2010 time period only (Figure 7). This, rather than meaning the rest being caught by truly domestic Gambian vessels, simply highlights the difficulty to retrace the real ownership of reflagged vessels. However, it is herein appropriate to assume that smaller vessels, notably purse-seiners targeting small-pelagics are truly Gambian. Domestic industrial catches increased to a peak of around 24,000 t·year^{-1} in 1985, then fluctuated with the number of vessels, with a decreasing trend to less than 5,000 t·year^{-1} in 2010 (Figure 7).

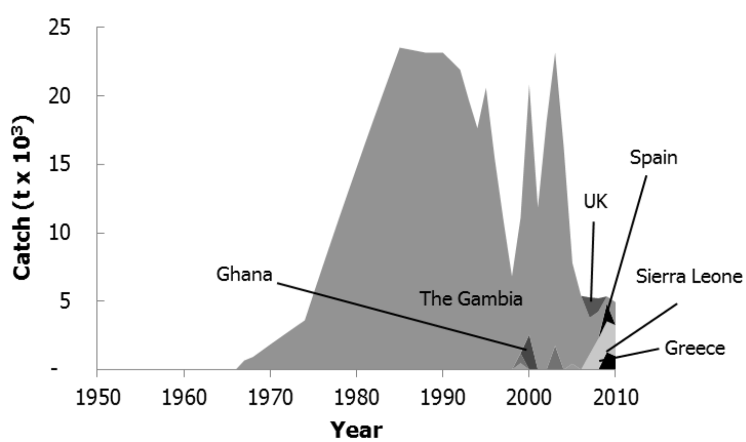

Figure 7. Reconstructed 'domestic' industrial catches, including catches by vessels reflagged to The Gambia, 1950-2010 (excl. discards).

Foreign industrial catches

Foreign industrial catches were estimated at 2.2 million t between 1968 and 2010. These catches increased from a very low value in the late 1960s to 45,000 t·year^{-1} in 1984, when Ghanaian vessels made up the entire foreign fleet, then sharply increased with the arrival of fleets from several countries to The Gambia, including from West Africa (Nigeria and Senegal), Western and Eastern Europe, Asia (notably Japan) and the Americas (FoC countries) to around 142,000 t·year^{-1} in 1990. Foreign catches declined thereafter with the decline of foreign fleets operating in The Gambia to less than 13,500 t·year^{-1} in 2010

(Figure 6). Today, most of catches are European (55%), Senegalese (17%) and Chinese (16%), while catches by fleets flagged to FoC countries declined from 7% in the mid-1980s and 1990s to 4% today.

Illegal and unregulated catches

Illegal and unregulated catches were estimated at 430,000 t between 1950 and 2010. Illegal and unregulated catches increased from low rates in the late 1960s to a peak of 25,000 t·year^{-1} in 1985, then declined gradually to less than 2,000 t·year^{-1} in 2010. The two countries generating these illegal and unregulated catches were the Soviet Union in the 1970s and early 1980s (attributed to present-day Russia), then China (Figure 8).

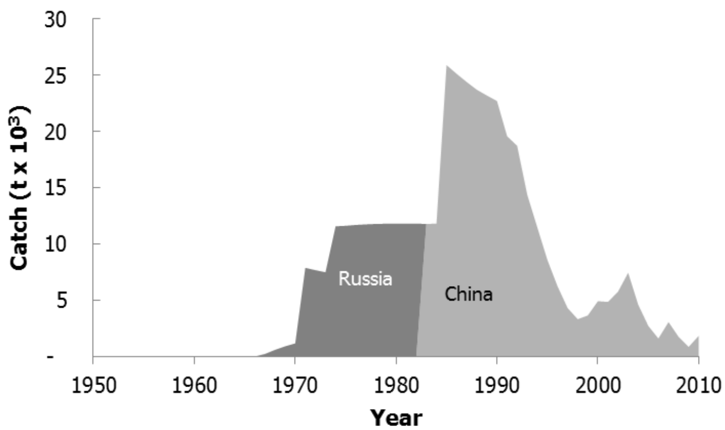

Figure 8. Reconstructed illegal and unregulated catches in The Gambia, 1950-2010.

Discards

Discards generated by the industrial sector were estimated at 1.3 million t between 1950 and 2010, of which 1.2 million t were by foreign trawlers. Discards increased from 300 t·year^{-1} in the late 1960s to 24,000 t·year^{-1} in 1974, and remained relatively constant between the mid-1970s and the mid-1980s at around 24,000 t·year^{-1}, then increased substantially after foreign trawl fleets arrived in The Gambia in the mid-1980s, including those associated with EU agreements. Discards decreased thereafter, notably to less than 14,000 t·year^{-1} in 1997 after the agreements with the EU were no longer renewed, and kept on decreasing with the decrease of industrial fleets operating in The Gambia and the emergence of discard recovery strategies by artisanal fisheries to less than 4,000 t·year^{-1} in 2010 (Figure 9).

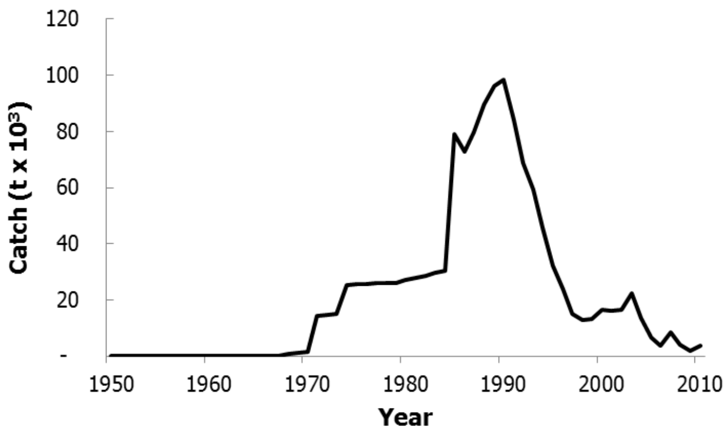

Figure 9. Reconstructed discards from The Gambia EEZ, 1950-2010.

Total catches

Total catches were estimated at 6 million t between 1950 and 2010. Artisanal fisheries, both estuarine and marine, represented around 20% of total catches, while the bulk of fish removals were taken by industrial and notably foreign fleets (3.9 million t) of which more than 1.7 million t are either discarded or caught illegally. Total catches increased from 5,700 t·year^{-1} in 1950, all small-scale, to a peak of 308,000 t·year^{-1} in 1990, driven by a sharp increase in industrial fisheries, which altogether (i.e., landings, discards and illegal and unreported catches) represented 75% of the total catch. Catches declined thereafter, probably due to the departure of a number of foreign industrial fishing vessels, to less than 76,700 t·year^{-1} in 2010.

Domestic catches were estimated at 2.2 million t between 1950 and 2010, compared to 875,700 t officially reported, i.e., 2.5 as high as the data supplied by The Gambia to FAO. Domestic catches increased rapidly between 1950 and 1980, when they reached 48,000 t·year^{-1} compared to 10,500 t·year^{-1} supplied to the FAO (78% unreported). Domestic catches remained relatively constant, with slight variations, at least compared to the increasing pattern in official datasets, between 1980 and the 2000s. Domestic catches were at their maximum in 2003 at 68,000 t·year^{-1} compared to 34,200 t·year^{-1} supplied officially (50%), which shows a decrease in underreporting (Figure 10a).

Taxonomically, the decline in bonga shad catches is compensated by the increase in sardinella and catfishes in the last decade, while shark and ray catches, which increased between the mid-1990s and the mid-2000s due to the lucrative shark fin market, decline thereafter, probably as a result of overexploitation (Figure 10b).

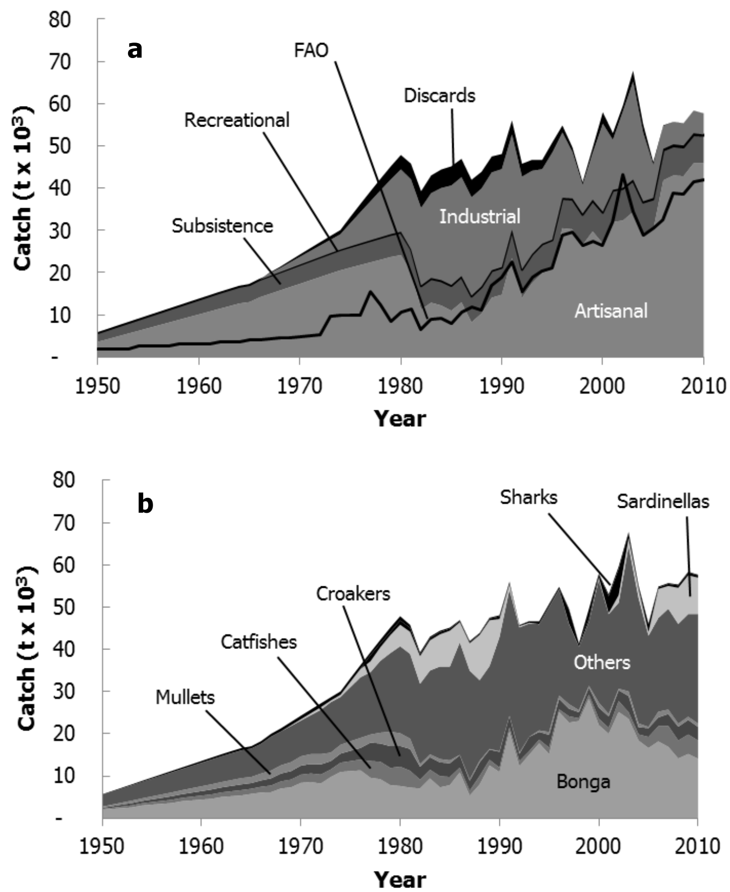

Figure 10. Total reconstructed domestic catches for The Gambia by (a) sector, and (b) taxon, 1950-2010.

DISCUSSION

Total catches from The Gambia EEZ were estimated at 6 million t between 1950 to 2010, and decreased since their peak of over 308,000 $t \cdot year^{-1}$ of the early 1990s. Reconstructed domestic catches were shown to be 2.5 times higher than the data supplied officially to FAO on behalf of The Gambia. However, this under-reporting component is decreasing, due to the establishment of regular catch assessment surveys. What most likely arises from this study is the scarcity of literature on the fisheries of The Gambia, perhaps due to the small size of the country and its fisheries catches, in comparison to the geographically dominating Senegalese neighbor. However, The Gambia has ceased to be a colony in 1965, and fisheries are one of the pillars of its food security.

Also, we noted that in recent years, licenses are granted to foreign vessels directly or through joint ventures, and that information about these (in contrast, e.g., to EU access agreements) are accessible only through requests to the government of The Gambia (Department of Fisheries)[5]. Thus, the very nature of this information contributes to the relative lack of visibility of the foreign fisheries in The Gambia, and makes their contribution to the economy and food security of the country less visible or accountable. Indeed, although poverty and food insecurity have increased since the late 1990s due to climate change and droughts (Kandji *et al.* 2006), and a high number of coastal Gambians are engaged in fishing activities for the least their personal consumption (Jaimovich 2011), officially, fisheries were completely

[5] The Department of Fisheries of the government of The Gambia kindly made information on these licence agreements available to the first author.

disregarded as an adaptation measure for at least the food security component. Here, we show that increasing subsistence catches could be a good indicator of a real ‘fish rush’ towards to coast as an adaptive strategy against droughts. Furthermore, fisheries in The Gambia support poverty alleviation by providing an alternative for better livelihoods for women and their households. Indeed, if in the past, subsistence fishers (e.g., shellfish collection) were 20% men, while today, over 90% of these fishers are women (Ngaido 1990; Njie and Drammeh 2011). With a price of around 15 GMD ($0.46US) for 150 g of processed shellfish (Njie and Drammeh 2011) and a conversion factor of 4.5, i.e., 1,019 t·year^{-1} of smoked shellfish in 2010, the value these women bring home to feed their families is estimated at $3.12 million US.

The largest part of catches estimated in the present study was taken by industrial fleets, notably those reflagged to The Gambia. Indeed, the present study shows an increase in the reflagging practices of The Gambia, particularly by vessels from the EU after the EU/The Gambia agreements were ended. This activity is risky, since cross-records of certain vessels involved in illegal activities elsewhere reveal the absence of background checks for previous records of illegal activities for these same vessels. Furthermore, the under-reporting of GRT, which in itself is illegal, generates an economic loss since many vessels, notably trawlers pay their licence fees based on the GRT. Thus, it is widely believed that these vessels tend to register locally to reduce fishing licence fees. Both local flags are cheaper, but also because the cost associated with monitoring (e.g., reporting of realistic GRT) are lower. Thus, the industrial vessel identification exercise conducted herein revealed that over half of the countries fishing in The Gambia under-reported the GRT of their vessels, and hence under-pay their license fee, a likely serious loss of state revenue for The Gambia. This issue appears to be most recurrent with African countries such as Nigeria and Ghana, with an under-reporting of 38%, followed by FoC countries by 26%, then countries of the EU (led by Greece) with 20% and finally China by 15%. Moreover, as the law requires each licensed vessel to land a minimum of 10% of annual catches in the country (or pay a monetary equivalent to the government), the under-reporting of foreign catches represents a monetary loss to the government of The Gambia (Agnew *et al.* 2010).

The present study highlights the lack of monitoring of industrial fisheries, despite increasing efforts by the government of The Gambia. While under-reporting of domestic fisheries declined over-time, foreign fisheries remain almost entirely unmonitored, a pattern also shown elsewhere in West Africa. The lack of monitoring leads to two major consequences: (1) over-exploitation (Drammeh and Mbenga 2002), which by itself leads to (2) economic loss and dangerous trends for domestic food security, as illustrated by the decline of the popular bonga shad.

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REFERENCES

Agnew D, Walmsley S, Leotte F, Barnes C, White C and Good S (2010) West Africa Regional Fisheries Project: Estimation of the cost of illegal fishing in West Africa. Final Report. MRAG, London. 99 p.

Allison EH, Perry AL, Badjeck M-C, Neil Adger W, Brown K, Conway D, Halls AS, Pilling GM, Reynolds JD, Andrew NL and Dulvy NK (2009) Vulnerability of national economies to the impacts of climate change on fisheries. Fish and Fisheries 10(2): 173-196.

Anon. (1979) Report of the Ad Hoc working group on coastal demersal stocks from Southern Mauritania to Liberia. Held at the Centre de Recherche Oceanographique de Dakar-Thiaroye, 14-19 November 1977. CECAF/ECAF Series 78, FAO, Rome. 1998 p.

Anon. (2006a) 2005 and 2006 Catch Assessment Survey report. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 61 p.
Anon. (2006b) The 2006 Fishery Frame Survey report. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 71 p.
Anon. (2007) 2007 Catch Assessment Survey report. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 39 p.
Anon. (2008) 2008 Catch Assessment Survey report. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 24 p.
Anon. (2009) 2009 Catch Assessment Survey report. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 47 p.
Anon. (2012) Cockle and oyster fishery co-management plan for the Tanbi Special Management Area, The Gambia. Ministry of Fisheries, Water Resources and National Assembly Matters, Banjul. 37 p.
Beaudry F, Folsom W and Rovinski D (1993) World fishing fleets: An analysis of Distant-Water Fleet operations. Past - Present - Future. Volume II. Africa and Middle East. NOAA Tech. Memo. NMFS-F/SPO-10. National Oceanic and Atmospheric Administration, Silver Spring, Maryland. 64 p.
Belhabib D, Koutob V, Gueye N, Mbaye L, Nhiamadio I, Mathews C, Lazar N and Pauly D (*In press*) Lots of boats and fewer fishes: catch reconstruction for Senegal, 1950-2010. *In* Belhabib D and Pauly D (eds.), Marine fisheries catches in West Africa Part II, 1950-2010. Fisheries Centre, Vancouver.
Bours H (2004) Illegal, Unreported and Unregulated (IUU) fishing in West Africa. Greenpeace, Rome. 12 p.
Caverivière A and Rabarison Andriamirado GA (1988) Captures secondaires et rejets de la pêche crevettière à Penaeus notialis du Sénégal 111, CRODT, Dakar. 113 p.
Dobo A (2009) Illegal Chinese fishing in West African waters. A study on Chinese IUU activities and its consequences to sicio-ecological systems. Ecosystems, governance and globalisation Master's programme thesis, University of Stockholm University, Stockholm. 54 p.
Drammeh O and Mbenga A (2002) The Gambia fishing agreements. pp. 51-59 *In* Lankester K, Diouf P and Sane K (eds.), Fisheries access in West Africa. Proceedings of two workshops held in Senegal and Mauritania, 2001. Scomber Consultancy, Saly Portudal.
Everett GV (1976) An overview of the state of fishery development and planning in the CECAF region. CECAF/ECAF Series 75, FAO, Rome. 67 p.
Freon P, Stequert B and Boely T (1978) La peche des poissons pelagiques cotiers en Afrique de l'Ouest des iles Bissagos au nord de la Mauritanie: description des types d'exploitation. Cah. O.R.S.T.O.M., Ser. oceanogr. XVI, O.R.S.T.O.M., Dakar. 19 p.
Horemans B, Ajayi T and Gallene J (1996) Sector review of artisanal marine fisheries in the Gambia. Technical report 80, IDAF, Cotonou.
Jabara C (1990) Economic reform and poverty in The Gambia. A survey of pre- and post-ERP experience. Monograph 8. Cornell Food and Nutrition Policy Program, New York.
Jaimovich D (2011) Macrostructure and microstructure: evidence from overlapping village networks in The Gambia Working Papers Series, Graduate Institute of International and Development Studies, Geneva. Available at: http://dx.doi.org/10.2139/ssrn.2208048 [Accessed: 10/09/2013].
Jaiteh M and Sarr B (2011) Climate change and development in The Gambia. Challenges to ecosystem goods and services. The Earth Institute, Columbia University, New York. 43 p.
Kandji T, Verchot L and Mackensen J (2006) Climate change and variability in the Sahel region: impacts and adaptation strategies in the agricultural sector. UNEP, London. 58 p.
Lazar N and Somers B (2011) Assessment of The Gambia Fisheries Data Collection Needs. Report to the USAID/BaNaafa project of the University of Rhode Island. Coastal Resources Center, URI. 13 p.
Lesack LFW and Drammeh O (1980) Strategic Plan for the fisheries sector of the Gambia (1994 – 2004). Fisheries Publication 33, Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 90 p.
Lhomme F, Bour W and Domain F (1975) La peche crevettiere a Dakar. DSP 52, O.R.S.T.O.M, Dakar. 45 p.
Madge C (1994) Collected Food and Domestic Knowledge in the Gambia, West Africa. The Geographical Journal 160(3): 280-294.
Manel CJP (2008) Analyse economique des effets induits par la peche recreative au Senegal: Cas de la petite cote et du Sine Saloum. Master Sciences de la Mer et du Littoral thesis, University of Agrocampus Rennes, Brest. 72 p.

Mbenga A (1996) Marketing and distribution of artisanal fisheries in The Gambia. Women as fish protein suppliers in The Gambia. University of Tromso. Norwegian College of Fisheries Tromso. 117 p.
Mbye E (2005) Shrimp fishery of the Gambia: a case study of shrimp fishing gears. The United Nations University, Reykjavik, Iceland. 26 p.
Mendy A (2002) The evolution of fisheries in The Gambia and fisheries statistics. The Gambia Fisheries Department, Dakar. 16 p.
Mendy A (2004) Trends in Gambian fisheries and fisheries statistics. pp. 69-78 *In* Chavance P, Ba M, Gascuel D, Vakily J and Pauly D (eds.), Pecheries maritimes, ecosystemes et societes en Afrique de l'Ouest: un demi-siecle de changement. Actes du symposium international. Dakar, Senegal, 24-28 Juin 2002. IRD, Dakar.
Mendy A (2008) Analysis of actors on The Gambia coastal environment. FIBA, Banjul. 36 p.
Mendy A (2009) An overview of The Gambia fisheries sector. Gambia Artisanal Fisheries Development Project. Department of Fisheries, Banjul. 30 p.
Miller DD and Sumaila UR (*In press*) Flag use behavior and IUU activity within the international fishing fleet: Refining definitions and identifying areas of concern. Marine Policy (0).
Ndiaye TM (2011) Illegal, Unreported and Unregulated Fishing: Responses in General and in West Africa. Chinese Journal of International Law.
Ngaido T (1990) Meat or shell? Traditional oyster fishery in The Gambia. Unpublished report for the International Development Research Centre (IDRC). Department of Fisheries, Banjul. 30 p.
Niang A (2008) Contribution à l'étude de quelques aspects socioéconomiques pour la réactualisation du plan de gestion du Parc National de Niumi (GAMBIE), University of Universite Cheikh Anta Diop Dakar, Dakar. 64 p.
Njie M (2007) Gambia National Adaptation Programme of Ction (NAPA) on Climate Change. Government of The Gambia, Banjul. 97 p.
Njie M and Drammeh O (2011) Value chain of the artisanal oyster harvesting fishery of The Gambia. Gambia-Senegal Sustainable Fisheries program (Ba Nafaa) Coastal Resources Center, University of Rhode, Narragansett, Rhode Island. 74 p.
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.
Scheffers W and Conand F (1976) A study of *Ethmalosa fimbriata* (Bodwich) in the senegambian region. 3rd note. The biology of the Ethmalosa in the Gambian waters. Doc. Sci. Cent. Rech. Oceanogr. Dakar-Thiaroye 59, ORSTOM, Dakar. 19 p.
Troadec J and Garcia S (1980) The fish of the Eastern Central Atlantic part one: The resources of the Gulf of Guinea from Angola to Mauritania. FAO Fisheries Technical Paper 186, FAO, Rome. 166 p.
Weber J and Durand H (1986) Le secteur des pêches dans les pays d'Afrique ONUDI, Dakar. 67 p.