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Rich Fisheries and Poor Data: A Catch Reconstruction for Angola, 1950-2010

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Abstract

Angola's coast lies within the highly productive Benguela Current Large Marine Ecosystem, which leads to abundant fisheries, which are notably attractive to foreign fleets. However, the data upon which any fisheries management plan would depend are often unreliable or nonexistent, and the only two sectors that are covered by official statistics, at least partially, are industrial and artisanal fisheries. Angola's situation worsened after independence from Portuguese rule in 1975, as monitoring was absent for over 30 years due to a tumultuous civil war. Domestic catches for Angola within its Exclusive Economic Zone-equivalent waters (EEZ) were reconstructed as 182,000 t·year^{-1} in the early 1950s, reaching a peak of 683,000 t in 1972, collapsing thereafter to a low of 131,000 t in 1976 with the departure of the Portuguese fleet and then increasing steadily, while remaining at low levels during the civil war, to 516,000 t in 2007. Domestic total catches were around 50% higher than the catch data reported by the FAO on behalf of Angola. Although this may seem low compared to other West African countries, under-reporting increased since the departure of the Portuguese but decreased slightly after the civil war. Foreign catches represented as much as one third to half of total removals from Angolan waters, most of which were never reported to Angola (although may have been reported to FAO by the flag country). Total foreign catches within the Angolan EEZ-equivalent waters peaked at over 400,000 t·year^{-1} in the early 1980s, and averaged around 250,000 t·year^{-1} in the 2000s. Around 65% of industrial catches are species that are also caught by artisanal fisheries. This overlap illustrates the importance of tackling the issue of under-reporting and illegal fishing in Angolan waters.

INTRODUCTION

Angola is located in Southwest Africa (capital city: Luanda 12°30'S; 18°30'E). Its mainland is located between Namibia in the south and the Democratic Republic of the Congo in the north, and with Zambia in the east and the Benguela Large Marine Ecosystem in the West. Cabinda, an Angolan exclave, is located between the Democratic Republic of the Congo and the Congo (Figure 1). Cabinda was a Portuguese colony called the 'Portuguese Congo', and is known today for its offshore oil fields, some of the largest in the world.

The location of Angola in the northern part of the Benguela Large Marine Ecosystem, where the cold, northward Benguela current meets the warm Angola current to create a strong upwelling system, is the reason why Angola's fish resources are abundant (FAO 2007b; Du Preez 2009). However, fisheries, like other sectors of Angola's economy, have been strongly impacted by the painful history and particularly the socio-political turmoil that beset the country since independence.

When the first permanent settlement of Luanda was founded in 1576 by the Portuguese, it began the colonization that would last until Angola's independence in 1975 (Anon. 2003). The first colonial period, marked by the international slave and ivory trade, was ended by the abolition of slavery in 1876 (Valério

and Fontoura 1994). However, control of lands and trading posts by a few thousands of European settlers over almost half a million indigenous people had only contributed to worsening the economic situation of the latter, and benefits driven from sectors like fisheries remained particularly restricted to settlers (Valério and Fontoura 1994).

Figure 1. The Exclusive Economic Zone (EEZ) and shelf waters to 200 m depth of Angola.

The year 1876 also marked the beginning of the 'second colonial period' known for the development of a prosperous national economy, as it opened to world international markets particularly after World War II (Valério and Fontoura 1994).This period lasted until 1975, when Angola's war for independence ended and Angola became one of the fronts of the Cold War, in the form of a vicious civil war by proxy, which lasted 30 years and devastated the country.

Notably, half a million people were killed and over a million were displaced (McGrath 1993; BBC 2013). At the end of the civil war in 2002, the country invested in rebuilding its economy. Angola experienced the fastest growing GDP in the world. Currently, Angola is the second largest oil producer in Africa and the world's fourth largest producer of diamonds. Despite this wealth, Angola is still ranked 148th out of 186 countries on the Human Development Index, with two thirds of its population living under the poverty line, thanks to the sequels of colonialism and civil war, aggravated by corruption and poor governance.

Conflicts were driving people to the coast (Medeiros 1982), and poor economic conditions and droughts (Anon. 2013) limiting agricultural opportunities for people, certainly contributed to making fisheries one of the few choices Angolans have for their livelihoods, despite often difficult working conditions. Indeed, the fishing sector is a major source of employment for many Angolans, contributing 126,000 jobs (Stop Illegal Fishing 2006). Two sectors are officially reported in Angola: the industrial (and semi-industrial) sector, mainly operated by the domestic reflagged fleet and the foreign fleet (currently operating as joint ventures), and the artisanal sector operated by boats of up to 14 m (Du Preez 2009). Other fisheries sectors exist, however, they are not officially monitored, i.e., subsistence and recreational fisheries (Du Preez 2009). Although official data show a drastic decline in marine fisheries catches due to

the turmoil of independence and civil war, the present decrease in the size of the fish caught and their catches points to overfishing (Lankester 2002; Embaixada da República de Angola em Portugal 2014), likely initiated by the foreign fleets that operated off the coast of Angola during the 1980s and continued into the 2000s, if to a lesser extent. These catches, along with those of small-scale fisheries are not known with any certainty (FAO 2007b), but would be needed to support any development strategy and to ensure food security of coastal populations of Angola, as fish constitutes a large part of the animal protein intake of Angolans.

Here, we reconstruct a coherent time series of total catches from the Angolan Exclusive Economic Zone (EEZ) between 1950 and 2010, which take these foreign fleets into accounts.

METHODS

Total and coastal population

Total population was extracted from the World Bank database (www.worldbank.org) between 1960 and 2010 and supplemented by the data from PopulStat (www.populstat.com). Estimates for rural coastal population living within 10 km of the coast were available through CIESIN (2012) for 1990, 2000 and 2010. We converted the latter to percentages, extrapolated the trend back, and estimated that in 1950, 1.3% of the total population of Angola was living in coastal rural areas. We interpolated linearly between these percentages from 1950 to 1990 and then multiplied them by the total population of Angola. Finally, we completed the coastal population time series by performing a series of linear interpolations (Figure 2).

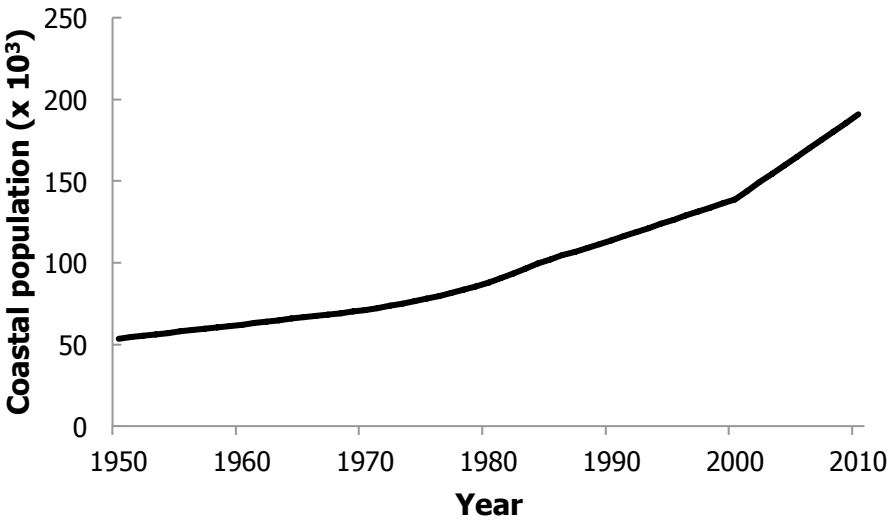

Figure 2. Estimated coastal population of Angola, 1950-2010.

Industrial catches

Industrial fisheries in Angola were dominated by foreign fleets whose catches are mostly unknown, while domestic fleets[1] are responsible for supplying catch data to authorities (Agostinho *et al.* 2005). This often results in catch under-reporting. Reported landings between 1953 and 1974 were all industrial (de Matos 1984). Likewise, the data reported by Lankester (2002) for industrial fisheries appear to overlap with the data reported to FAO between 1950 and 1999, i.e., the data reported to FAO for this time period included only industrial catches. For later periods, the industrial reported catch was deemed to be the difference between the data reported to FAO and the artisanal landings available between 2000 and 2004 (Norfolk *et al.* 2006), and as 60% of the data reported to FAO between 2005 and 2010, which corresponds to the percentage of industrial landings over the total landings for 2003 and 2004. Industrial catches were reported fairly rigorously until at least 1957 (Coelho and Stobberup 2001). Lankester (2002) gathered what were referred to as unreported catches, taken mostly by foreign fleets, notably Russian vessels prior to the collapse of the Soviet Union between 1975 and 1994; for the latter year, unreported catches were 112% of the reported catch. We carried on this trend until the end of the civil war, given the absence of any monitoring or enforcement, and assumed it declined linearly by half in 2010. We applied the resulting under-reporting rates to the reported landings between 1995 and 2010. We also interpolated linearly between zero unreported catches in 1957 (Coelho and Stobberup 2001) to the unreported catch in 1975 (Lankester 2002).

Reported catches were assumed to be Angolan, although in reality, they were mostly Portuguese and foreign during Portuguese rule (Agostinho *et al.* 2005), and Angolan, Russian (pelagic fisheries) and Chinese (demersal fisheries) under joint ventures after 2004. The unreported component represented catches that were taken by foreign fleets, the majority taken by Russian fleets (Lankester 2002), herein 50%, 30% by the EU including Spain, Italy and Portugal before the withdrawal of the EU from Angola (Preez 2009) and the remaining 20% divided evenly between Ukraine, Nigeria, Lithuania, Japan and Angola between 1950 and 2004 (Agostinho *et al.* 2005) and China and Russia and Angola between 2004 and 2010 (Preez 2009).

We used the species disaggregation found in the FAO dataset for the most recent years (which provides the best taxonomic resolution) to disaggregate unreported catches, while accounting for the fact that foreign fleets used midwater trawls for catching pelagic taxa, and bottom trawls for demersal species (Norfolk *et al.* 2006; Stop Illegal Fishing 2006).

Illegal catches

In Angola, like elsewhere in Africa, illegal fishing is substantially contributing to the depletion of marine resources, i.e., ”foreign trawlers have hammered patches of coastline so hard that fish have become locally scarce--a blow to a nation where a million people rely on UN food aid” (Salopek 2004; Agnonotícias 2013). Furthermore, illegal fishing in Angola is increasing due to the almost complete absence of monitoring capacity (Lankester 2002; Agnonotícias 2013). The sea patrol units acquired recently (Angodenúncias 2014) lack the capacity of covering a large range of the Angolan EEZ, notably due to lack of fuel (Salopek 2004), which is utterly surprising given that Angola is a continental leader in oil-extraction. This lack of capacity is easily illustrated by daily incursions of industrial fishing vessels into artisanal fishing areas (Ojukwu *et al.* 2013). Illegal fishing activities include fishing in closed areas, illegal fishing gear, illegal mesh size, and fishing without a license, the latter commonly recurrent in Angolan waters (Stop Illegal Fishing 2006). Examples of illegal fishing in Angola often involve Chinese vessels with

[1] The Portuguese fleets operating in Angola that were based in Angola prior to independence are considered domestic here.

African crew (ANGOP 2013), with a number of vessels arrested in very short time periods in the 2000s (ANGOP 2009; DN 2012; O País 2014). These illegal fishing activities are not limited to Chinese trawlers and longliners flying Flags of Convenience (FoC; Gianni and Simpson 2005; MRAG 2005); other fleets, from Korea, Spain, Namibia, Japan and Russia are also involved in illegal fishing activities (Salopek 2004).

The available evidence suggests that China is the major contributor to illegal fishing activities in Angola in recent times (Salopek 2004). Often, these activities are related to other criminal actions, such as loss of life: "At least two Angolan inspectors have vanished mysteriously while on observer duty aboard large industrial trawlers - suicides, assert the foreign skippers, pushed overboard, the fisheries police insist" (Salopek 2004).. Corruption also plays a significant role in illegal fishing: politicians "are using the oceans as a bank account" (Salopek 2004). Along with Chinese illegal trawlers which can catch 320 $t \cdot boat^{-1} \cdot year^{-1}$ assuming 4 fishing trips and 80 $t \cdot boat^{-1} \cdot trip^{-1}$ (Salopek 2004)[2], Korean mother-ships carry Senegalese pirogues onboard to fish in Angolan waters. This activity exploded in the 1990s, and in 1998 100 Senegalese pirogues were confiscated (Sall *et al.* 2002).

We conservatively assumed the number of Senegalese pirogues arrested represented the total number of pirogues involved in illegal fishing in 1998, and then assumed a linear increase of 10% by 2010. We interpolated linearly between 0 illegal Senegalese pirogues in 1990, 100 in 1998 and 110 in 2010, and then multiplied the resulting effort by a CPUE of 125 $t \cdot pirogue^{-1} \cdot year^{-1}$ (Belhabib *et al.* 2014a). We applied a taxonomic catch disaggregation by filtering out species that were reported by Korea in FAO area 47, i.e., species of interest to Korea, which were also caught by the artisanal fleet.

In 2004, over 25 days of aerial surveillance, 199 vessels were spotted, 29 of them were committing serious infringements, 13% of these were fishing with no licenses (MRAG 2005), i.e., around 4 vessels every 25 days, translating into an equivalent of 55 unlicensed vessels per year in 2004. In 2009, 7 vessels were arrested for illegal fishing during a campaign of 2 weeks (ANGOP 2009), which translates into an equivalent of 170 vessels fishing illegally in 2009. We interpolated the number of illegal fishing boats linearly between 0 in 1982, when Angola declared its EEZ to the anchor points estimated above. We assumed the CPUE was 320 $t \cdot boat^{-1} \cdot year^{-1}$ across all fleets for 2004, which is a very conservative estimate compared to that of 9,000 $t \cdot boat^{-1} \cdot year^{-1}$ estimated using effort and catch data by MRAG (2005) which included illegal, unregulated and unreported catches. We assumed the CPUE was 10% higher in 1982 and was 10% lower in 2010, and interpolated linearly. We multiplied the effort by the estimated CPUE and then assumed 80% of these catches were taken by Chinese vessels, the remaining by Japan, Russia, Namibia and Spain, allocated equally.

Discards

A report states that during a typical fishing operation by Chinese trawlers "two basketfuls of prized sole, bream and skates, the rest of the dead and dying catch is scraped over the side of the giant Chinese trawler, full to the knees of marine life" (Salopek 2004). These fish are called "wrong fish" by the crew (Salopek 2004). Discards are not limited to Chinese vessels, as overall demersal finfish and shrimp trawl fisheries in Angola are understood to generate significant discards (COFREPECHE 2013). However, the small-pelagic purse-seine and artisanal fisheries appear to have generated less discards of low value species (Kelleher 2004). Discards of the shrimp fishery were estimated at 70% of the total catch, i.e. for every 1 kg of shrimp caught, 2.33 kg of marine life are discarded (Kelleher 2004; COFREPECHE 2013). Similarly, demersal finfish fisheries discard around 40% of total catches, and purse-seine and artisanal fisheries generate discards of 5% and 1%, respectively (Kelleher 2004). We applied these percentages to shrimp trawl, demersal trawl, purse-seine and artisanal fisheries catches per fishing country and obtained total discards between 1950 and 2010.

[2] These CPUE values are much lower than the values estimated in Pauly *et al.* (2013).

Since no species breakdown for discards was available, we used the species breakdown provided in Belhabib *et al.* (2014b) and assumed that purse-seiners discarded clupeids as they do in Namibia (Belhabib *et al.* 2014c).

Artisanal catches

Artisanal fisheries constitute the main livelihood of Angolan coastal communities (Anon. 2003). Fishers use boats called *piroga, chata* and the *catronga*, either canoes made of wood or fiberglass, more sophisticated small-planked open boats or boats with an inboard engine (IPA 2002). Furthermore, beach-seining occurs in 47 out of the 102 fishing communities (IPA 2002) and employs 100,000 fishers in addition to the 35,000 using boats (Sowman and Cardoso 2010). Historically, Angolans were excluded from the artisanal fishing sector by the Portuguese until their rule ended in 1975 (Sowman and Cardoso 2010). With the civil war, a large number of people migrated towards the coastal zones where fishing became an alternative livelihood (Sowman and Cardoso 2010).

Anchor points for the number of fishers were reported for 1979 (Guerra 1979) and for the number of fishers and boats for 1991 (fishers only), 1995, 1998, 2000, 2001 (IPA 2002) and 2010 (Sowman and Cardoso 2010). The number of fishers declined between 1970 and 1979 (Guerra 1979), and we assume this decline was by 80% (Table 1). We estimated the number of fishers for 1950 by assuming the percentage of fishers in the coastal population was constant between 1950 and 1970 during the colonial period and then multiplied this percentage by the coastal population for 1950 (Figure 2) to obtain the number of fishers for 1950 (Table 1). Since artisanal fisheries did not change substantially over time (O País 2012), we assumed the number of fishers per boat remained constant between 1950 and 1995, i.e., 5 fishers per boat (Krantz 1984; Agostinho *et al.* 2005). We obtained the number of boats by dividing the total number of fishers by the number of fishers per boat for 1950, 1970, 1979 and 1991 and then completed the time series for the number of boats by performing a series of linear interpolations.

In the early 1980s, artisanal fishing boats were given by Sweden to Angolan in the context of a development project (Krantz 1984). The purpose of the study by Krantz (1984) was to evaluate whether this project achieved its aims, as well as to provide an in-depth socio-economic study of numerous artisanal fisheries in Angola (Krantz 1984). Additionally, this study gave catches per boat for several fisheries, which enabled calculating the CPUE for boats in Luanda, *Barra do Dande, Ambriz, Soyo* and Cabinda.

In the context of the study (Krantz 1984), catches, number of fishing days and number of landing occasions allowed to estimate the CPUE by dividing the catch per pirogue by the number of fishing days in Luanda, i.e. 64 ± 9 kg·boat^{-1}·day^{-1}. It is worth mentioning that the black market that exists in Luanda hides some unreported catches, as the CPUE estimate is based on what has been reported to the fishing association (Krantz 1984). *Barra do Dande* fishers have always been involved in the sea, and the fact that this market is adjacent to the river as opposed to Luanda, makes the fishery relatively more successful than in Luanda even with smaller boats. There is no fishing authority or a fishers association; there is no control of prices and no official statistics system (Krantz 1984). Taking the average monthly CPUE (Krantz 1984), and assuming that it applies to the entire year, provides a CPUE estimate of 21,525 ± 1,872 kg·boat^{-1}·year^{-1}. In *Ambriz*, there appears to be no black market and fishers appear more reliable and transparent in terms of reporting their catches (Krantz 1984). We estimated the CPUE using the same method as previously at 8,288 ± 3,181 kg·boat^{-1}·year^{-1}. There is an association of fishers in *Soyo* which supplies the fishers with all of their needs (Krantz 1984). However, it differs in that Luanda does not have any external support and thus very limited resources to offer their members, while *Soyo* is directly aided by the Swedish support sector and therefore can fulfill many needs (Krantz 1984). Krantz (1984) provided monthly catches per boat, which we averaged and expanded annually to estimate an average CPUE of 6,804 ± 1,816 kg·boat^{-1}·year^{-1}. A fair but limited amount of fish is sold on the black market.

Cabinda is an isolated patch of Angola. It is economically tied more to its surrounding regions, the Democratic Republic of the Congo and Congo Brazzaville. Most of the fish that was eaten in the past was landed by Soviet trawlers (Krantz 1984). Following the previous approach using the data provided by Krantz (1984), we estimated the average annual CPUE at 12,934 ± 6,188 kg·boat^{-1}·day^{-1}. Therefore, the average artisanal CPUE for all locations was estimated at 13.1 t·boat^{-1}·year^{-1} for 1984. Similarly, we estimated the CPUE for 2002 by dividing the catch estimate provided by Norfolk *et al.* (2006) by the number of boats. However, we adjusted the latter by adding a conservative 30% given that only 55 landing sites out of 102 (Agostinho *et al.* 2005) were covered, and there was no evidence of extrapolation. Indeed, ArtFish, which allows these kind of geographic extrapolations based on a sample, is not used properly if used at all (Agostinho *et al.* 2005). We assumed the CPUE between 1950 and 1970 was 20% higher than the CPUE in 1983 (Agostinho *et al.* 2005), i.e., 15.73 t·boat^{-1}·year^{-1} for 1950-1970, and then declined by 5% between 2002 and 2010, i.e. 18.5 t·boat^{-1}·year^{-1} for 2010. We linearly interpolated the CPUE estimates and multiplied these by the effort (number of boats) to estimate total artisanal catches in Angola.

The number of boats for Cabinda was provided for 1991 (22% of the total effort), 1995, 1996, 1998, 2000, 2001 and 2003 (19% of the total effort) (IPA 2002; Agostinho *et al.* 2005). We assumed the percentage of the number of boats in Cabinda over the total was constant between 1950 and 1991) and between 2003 and 2010 and estimated the number of boats for the latter years (Table 1). We interpolated linearly and then multiplied by the artisanal CPUE to estimate artisanal catches in Cabinda province (already included in total artisanal catches).

We disaggregated catches using the taxonomic breakdown provided by (Agostinho *et al.* 2005).

Subsistence catches

Small-scale fisheries have traditionally been a subsistence activity by the population living along the coast and has been transmitted from generation to generation. In order to escape the ravages of war, many people fled from the country's interior to the coastal zones for safety, i.e., to Luanda, Namibia, Benguela and *Kwanza Sul* (FAO 2007a). This, along with the low purchasing power of Angolans and the fact that many part-time workers depended on fish, contributed to making subsistence fisheries an important source of protein for coastal populations (Urquhart 1963; de Sousa Ferreira 1985).

Subsistence fishers can catch up to 20 kg·fisher^{-1}·day^{-1} (Sowman and Cardoso 2010). The literature places subsistence catches between 30% of total reported landings (Macauhub 2014) and the equivalent of artisanal catches for 2010 (da Silva 2012), as half of total artisanal catches are given to the crew, while the other half is sold. Therefore, assuming the number of artisanal fishers is equivalent to the number of subsistence fishers, the total number of subsistence fishers for 2010 would be 135,000 including those operating on boats and those operating beach seines (Sowman and Cardoso 2010). We assumed subsistence fishers operated twice a month, as it is very occasional in nature, and that the CPUE in that fishery is 20 kg·fisher^{-1}·day^{-1} (Sowman and Cardoso 2010), i.e., subsistence catches were estimated at 64,800 t·year^{-1}, which is lower than literature estimates (da Silva 2012; Macauhub 2014). Krantz (1984) assessed the subsistence catch taken home by artisanal fishers; crew members are allowed to take 30 kg of fish home for their personal consumption per landing occasion, each boat has 5 crew members (Krantz 1984). Using the number of fishing days per landing occasion, we converted this estimate to take-home catch per fishing day, i.e., 33 kg·boat^{-1}·day^{-1} (we also assume that the number of days was conservatively 250 fishing days, equivalent to 21 fishing days per month). Crew members in *Ambriz* are allowed to take 5 kg for personal consumption per landing occasion (Krantz 1984); however they take much more, herein assumed 15 kg. As Krantz (1984)did not report the number of landing occasions, we used the ratio *subsistence:artisanal CPUE* for Luanda, i.e., for each one kg of fish landed per boat, 0.51 kg were taken home. Therefore, for every 29 kg of fish landed in *Ambriz*, 15 are taken home for

consumption, which is equivalent to 4,287 kg·boat^{-1}·year^{-1}. Krantz (1984) described that part of the catch in *Soyo* was taken home by fishers without specifying the amount. However, since a fair amount is taken home as the fishery is described to be mainly for subsistence, we assumed subsistence catches were at least equivalent to artisanal catches, which translates into 6,804 kg·boat^{-1}·year^{-1} of subsistence catch. Following the previous approach using data provided by Krantz (1984), we estimated the subsistence catch for Cabinda at 3,519 kg·boat^{-1}·year^{-1}. We averaged these CPUE rates and obtained a subsistence CPUE of 5,689 kg·boat^{-1}·year^{-1} or 1,161 kg·fisher^{-1}·year^{-1} assuming 5 fishers per boat (Krantz 1984). For the same year, we estimated the number of fishers operating in the beach seine fishery by assuming the proportion *beach seine fishers:boat fishers* estimated at 2.86 using data provided by Sowman and Cardoso (2010) was the same over time, i.e., 22,013 beach seine fishers in 1984.We multiplied the CPUE per boat by the number of boats and the CPUE per fisher by the number of beach seine fishers and obtained a total subsistence catch of 34,720 t·year^{-1} for 1984. Similarly for 1950, we first estimated the number of beach seine fishers applying the same method as above, but assumed the CPUE was 20% higher, i.e., 6,827 kg·boat^{-1}·year^{-1} or 1,393 kg·fisher^{-1}·year^{-1} , given the more recent over-exploitation pattern in Angola. We multiplied the CPUEs by the number of boats and the number of beach-seine fishers (9,909), respectively, and estimated total subsistence catches at 18,754 t·year^{-1} for 1950. We interpolated linearly the previous estimates to complete the time series. We extracted catches from Cabinda by using the same proportions as for artisanal fisheries and then disaggregated subsistence catches using the same species disaggregation as for artisanal fisheries.

Recreational catches

Although catches and fish sizes are declining, e.g. West Coast dusky kob (*Argyrosomus coronus*) (Potts *et al.* 2011), suggesting a loss of value of recreational fisheries, there has been increasing interest in Angola's recreational fisheries, illustrated by a growing number of foreign recreational fishers in recent years (Potts *et al.* 2009). Fishers spend 6 days fishing per visit (Potts *et al.* 2011)

Catch per fisher data were recorded for 1974-1975 and 1992-2013 (Anon. 2014), published in www.fapd.co.ao. Although these data may refer to trophy catch (average: 2.83 ± 1.07 kg·fisher^{-1}·hour^{-1}), these data were not significantly different from the catch per fisher data provided by Potts *et al.* (2009) between 2005 and 2010 (average: 2.2 ± 0.03 kg·fisher^{-1}·hour^{-1}). The latter provided the CPUE per species for 2005, 2006 and 2010 for West Coast kob, shad (*Pomatomus saltatrix*) and leerfish (*Lichia amia*) which constituted 87% of the total CPUE. We added 13% to these, interpolated linearly and then compared these to the data provided by Anon. (2014) for the same period (Figure 3).

Interestingly, recreational CPUE estimated using nine *YouTube* videos resulted in similar results (average: 2.56 ± 0.53 kg·fisher^{-1}·hour^{-1}) (Figure 3). Therefore, we derived a trend line which allowed us to obtain the annual CPUE between 1974 and 2010; we extrapolated backwards to complete the dataset for 1950-1973. For the number of fishers, the periods where records were absent corresponded to the civil war, i.e., 1975-1991, 1993, 1998, 2001-2002, which shows that the latter was directly related to foreign visits to Angola. On the other hand, the presence of records as early as 1974 reveals that there was recreational fishing during the Portuguese colonial period. There are three main lodges catering to tourists for recreational fishing, Flamingo Lodge (www.aasafaris.com), which welcomed 655 recreational fishers with an accommodation capacity of 48 rooms (Potts *et al.* 2009), Kwanza Lodge, which has a capacity of 24 to 48 people per day, i.e. conservatively 328 tourists (assuming the same proportions as Flamingo Lodge) and Cunene Lodge with a capacity of 15 people per day, i.e., 195 people annually (www.aasafaris.com). This provides a total of 1,208 recreational fishers per year for 2010. We assumed the number of recreational fishers in 1950 was half of that in 2010, and then kept this number constant until 1974, assumed it to be 0 in 1975, and was 1% of the number of fishers of 2010 for the years 1992, 1999 and 2000 when records were present. The number of recreational fishers was assumed zero for

the years 1975-1991, 1993, 1998, 2001-2002, and interpolated linearly between 2002 and 2010. Assuming 5 hours of fishing per day, and 6 days per tourist, we multiplied the CPUE by the number of fishers and obtained total recreational catches for Angola.

To disaggregate recreational catches, we calculated the percentage contribution of each documented species between the period 1974 to 2010 using the above mentioned references, interpolated linearly to fill in the gaps and assumed the species disaggregation was constant between 1950 and 1974.

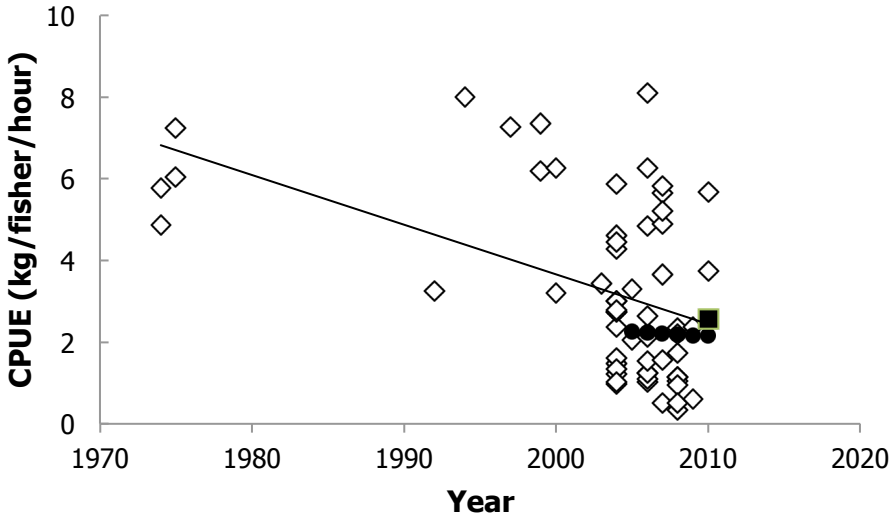

Figure 3. Observed and estimated CPUE of recreational fishers comparing various sources, squares (Anon. 2014), cross (Potts *et al.* 2009) and triangle (YouTube).

RESULTS

Industrial landings

Industrial domestic landings increased from 135,700 t·year^{-1} in 1950 to a peak of 604,000 t·year^{-1} before independence from Portugal and then declined drastically after the departure of the Portuguese domestic fleet to 78,100 t·year^{-1} in 1976, their historical minimum (Figure 4a). Domestic landings remained constant at around 109,000 t·year^{-1} between then and the mid-1980s, before increasing to a peak of 255,000 t·year^{-1} in 2007 and declining thereafter (Figure 4a). Foreign legal landings increased from 5,000 t·year^{-1} in 1958 to a peak of over 369,000 t·year^{-1} in 1983 at the height of the civil war, when monitoring was at its lowest (Figure 4b). Foreign landings subsequently decreased to around 91,600 t·year^{-1} in 1993, then increased to a second peak of 253,600 t·year^{-1} in 2002, before decreasing to about 93,200 t·year^{-1} in 2010 (Figure 4b). Foreign landings were dominated by Russia (former Soviet Union) and Spain in the past, and Russia and China in the 2000s (Figure 4b).

The industrial fisheries caught and landed mostly Cape hakes (*Merluccius* spp.), tunas and Cape horse mackerel (*Trachurus capensis*). Catches of Cape hakes decreased and catches of demersal species, such

as soles (*Cynoglossus* spp.) increased (Figure 4c), due to a shift in the fishing fleet when the EU withdrew from the EU-Angola agreements negotiations.

Illegal catches

Illegal catches by industrial fleets increased drastically from low levels in 1983 to a peak of around 49,900 t·year^{-1} in 2010 (Figure 5a). Illegal catches taken by Senegalese pirogues transported to Angola onboard Korean mother-ships, increased from 1,400 t·year^{-1} in 1990 when this activity began to 12,500 t·year^{-1} in 1998 and then remained relatively constant at around 13,500 t·year^{-1} during the late 2000s (Figure 5a). China and South Korea (through Senegalese pirogues) contributed the most to illegal catches (Figure 5a).

Taxonomically, there were over 80 taxa caught by illegal fleets, however tunas (*Thunnus* spp.), and other large pelagics (e.g., Xiphiidae), as well as Sparidae and Sciaenidae represent over half of these catches (Figure 5b).

Discards

Discards (both industrial as well as artisanal) increased from around 13,400 t·year^{-1} in 1950 to a first peak of 65,500 t·year^{-1} in 1972, a second peak of 82,700 t·year^{-1} in 1984, declined to 32,400 t·year^{-1} in 1993, and then increased to consecutive peaks of around 99,600 t·year^{-1} in 2001 and 104,000 t·year^{-1} in 2007 (Figure 6). Although shrimp trawlers are known to have a higher rate of discarding in Angola, demersal finfish trawlers contributed the most to total discards in quantity between 1950 and 2010 (Figure 6).

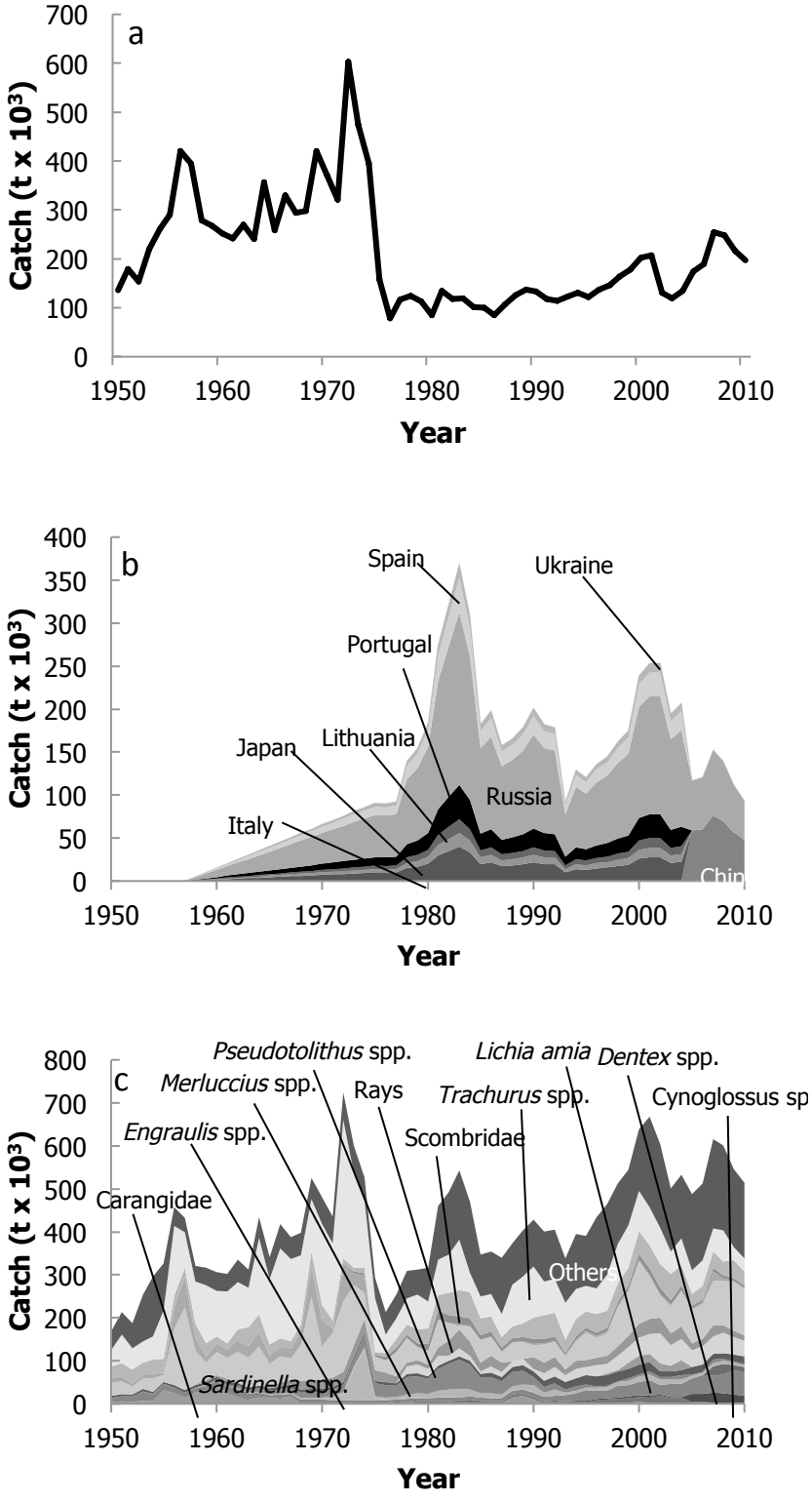

Figure 4. Reconstructed industrial fisheries landings from Angola EEZ by a) the domestic fleet; b) the foreign legal fleet by country; and c) major taxa, 1950-2010.

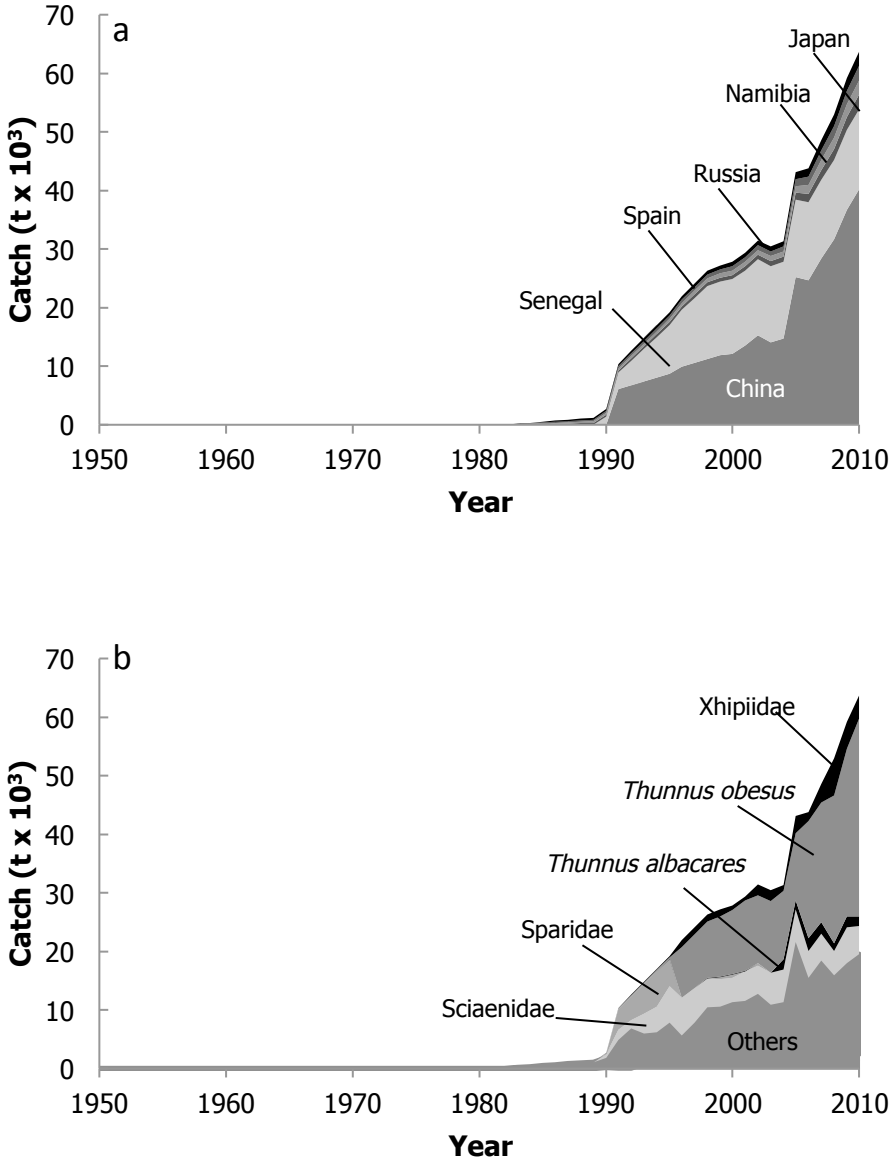

Figure 5. Reconstructed illegal catches from Angolan waters by a) country; and b) taxon, 1950-2010.

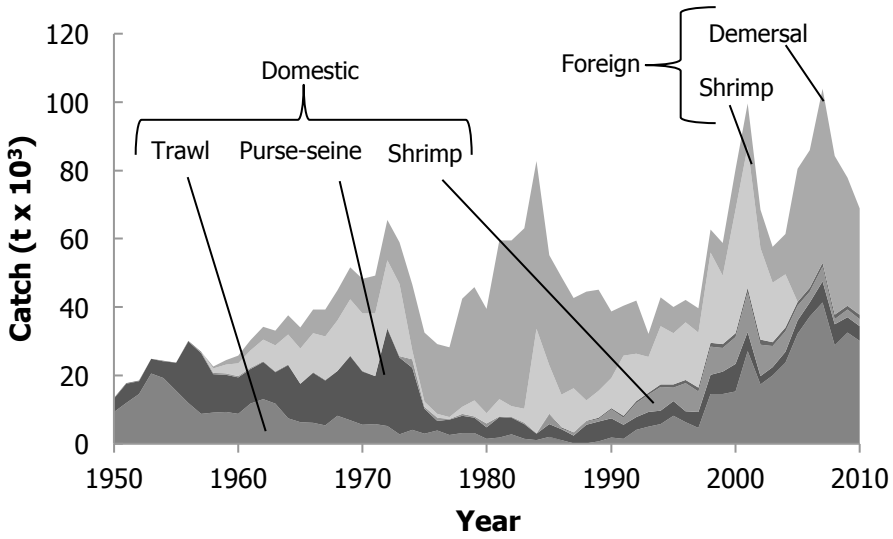

Figure 6. Total reconstructed discards by sector from the Angolan EEZ, 1950-2010.

Artisanal and subsistence catches

Artisanal catches (excluding discards) remained steady at around 14,000 t·year^{-1} between 1950 and 1970, decreased to 11,800 t·year^{-1} in 1979 due to the decrease in the number of fishers, and then increased rapidly to around 159,000 t·year^{-1} by 2010 (Figure 7).

Subsistence catches increased steadily, likely due to increasing migrations towards the coast during the civil war, from around 20,000 t·year^{-1} in 1950 to 65,000 t·year^{-1} in 2010 (Figure 7).

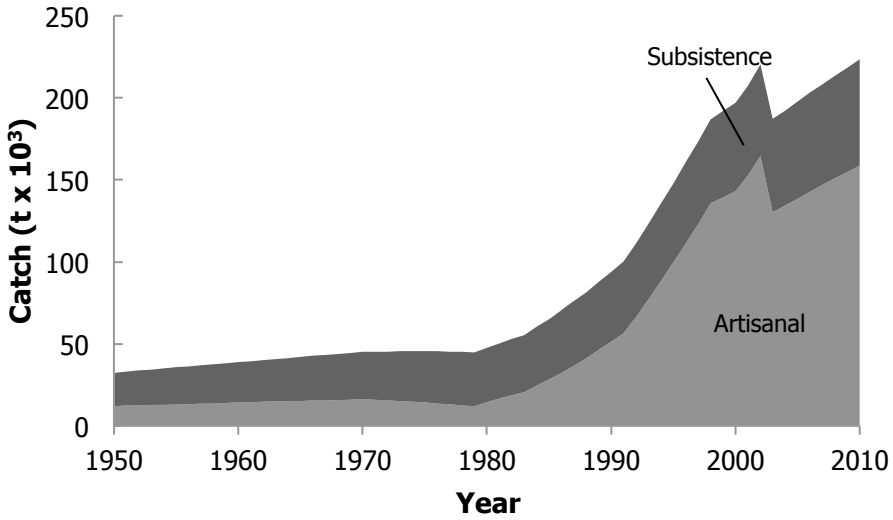

Figure 7. Total reconstructed small-scale artisanal and subsistence catches from Angola, 1950-2010.

Recreational catches

Recreational catches were estimated at around 180 t·year^{-1} in 1950, decreased to 0 in 1974, and generally remained non-existent throughout the civil war period, before increasing again to 92 t·year^{-1} in 2010 (Figure 8). Taxonomically, recreational catches included sailfish and sharks before independence and shifted to leerfish, kob and shad after the civil war (Figure 8), likely due to the change in clientele from Portuguese to South Africans.

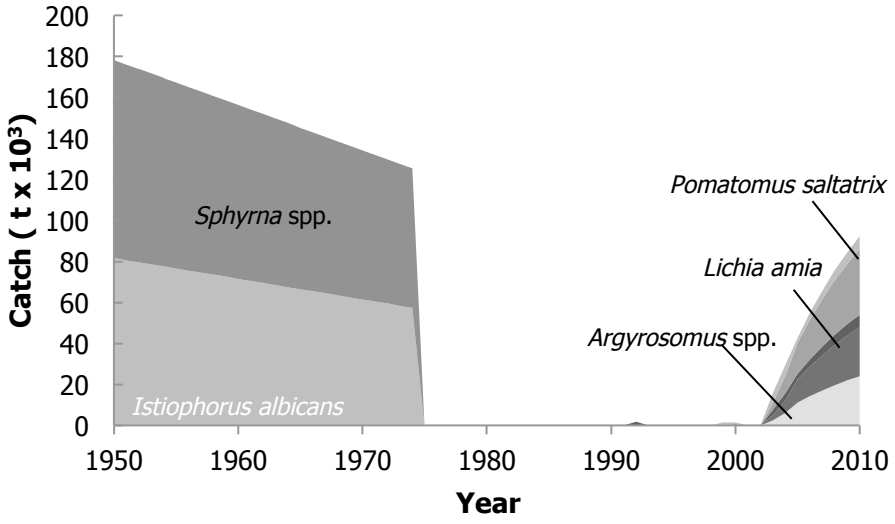

Figure 8. Total reconstructed recreational catches from Angola EEZ, 1950-2010.

Total catches

Total removals from Angolan EEZ-equivalent waters (including from the Angolan exclave Cabinda) increased from around 181,700 t·year^{-1} in the early 1950s to a first peak of 790,000 t·year^{-1} in 1972, before collapsing to 243,000 t·year^{-1} in 1976 (Figure 9). Total catches increased thereafter due to the increase in foreign industrial catches to approximately 607,000 t·year^{-1} in 1983, declined to 385,000 t·year^{-1} in 1993, before increasing again to average just under 709,000t·year^{-1} in the late 2000s (Figure 9a). During the initial time period prior to independence and the subsequent civil war period, total catches were dominated by domestic (i.e., Portuguese colonial) industrial fleets. During the civil war period, foreign industrial fishing expanded substantially, while an increasingly re-surging domestic industrial (including joint venture), and especially artisanal sector grew in importance in more recent times (Figure 9a). Overall, domestic catches were 22% higher than the data supplied to the FAO prior to independence, about twice as high as the data supplied to the FAO during the civil war, and 82% higher thereafter.

Catches in Cabinda, located in the Eastern Central Atlantic area were almost completely unreported. Catches were nearly all small-scale, increased from around 7,300 t·year^{-1} in 1950 compared to less than 0.5 t·year^{-1} reported to FAO, to a peak of around 29,800 t·year^{-1} in 1979, and then decreased, due to the decrease in the number of fishers to around 10,600 t·year^{-1} in 1995 (as opposed to zero reported to the

FAO), before increasing again to 42,400 t·year^{-1} in 2010, with no catch reported to FAO from this area (Figure 9b).

Taxonomically, off the 180 taxa that are caught from Angolan waters, Cape horse mackerel (*Trachurus capensis*), sardinellas (*Sardinella* spp.), Cape hakes, tunas (Scombidae) and croakers (*Pseudotolithus* spp.) dominate (Figure 9c). Cape horse mackerel and Cape hake catches declined strongly over time, while sardinella catches increased (Figure 9c).

DISCUSSION

Total catches from Angolan waters were estimated herein at 181,700 t·year^{-1} in 1950, peaking in 1972 at over 790,000 t·year^{-1}, followed by a collapse to 243,000 t·year^{-1} in 1976 and then increased steadily to 768,000 t·year^{-1} in 2007. Angola is a good example illustrating how socio-political conditions in the country could impact fisheries. For example, the under-reporting component was shown to be at its highest during the civil war, when fisheries monitoring was not a priority. Similarly, industrial domestic fisheries collapsed during independence in the mid-1970s, while foreign fisheries flourished and peaked at the height of the civil war, notably because of the lack of surveillance and associated absence of any control.

Similarly, while artisanal fishing opportunities were restricted during the Portuguese rule, subsistence fisheries increased during the civil war mostly due to strong migrations towards the coast, where fisheries are often sought to be the only available livelihood opportunity (Medeiros 1982).

Cabinda, part of Angola located between the two Congos, seems to be isolated in terms of catch reporting. Indeed, only a few catches, all industrial, were reported for this area between 1953 and 1990, and no small-scale catches were reported. The catch pattern observed for Cabinda also illustrates the marginalization of this area of Angola, as small-scale catches were relatively more important and showed an increasing pattern despite restrictions by Portugal, and high conflict occurrence.

This reconstruction also shows substantial uncontrolled and unmonitored presence of foreign fleets in the EEZ-equivalent waters of Angola during the civil war. Indeed, foreign legal and illegal (after declaration of its EEZ in 1990) fleets generated around half of the total removals from Angola between 1974 and 2002, thereafter their contribution declined to around a third when efforts of monitoring increased. However, their catches still remain relatively high as illegal fishing increases. Furthermore, there is a strong overlap between the species taken by the industrial fleet and those taken by the artisanal fleet, which explains why the finger is often pointed at industrial fleets when depletion is mentioned (Salopek 2004).

Despite this depletion, Angola is still perceived to be one of the best recreational fishing destinations in West Africa. This is clearly illustrated by the rapid increase in recreational fisheries catches. However, as opposed to Namibia, where recreational fishing is limited through bag-limits, fishing permits and restricted fishing areas, Angola has large room for progress as data are scarce and monitoring of recreational fisheries non-existent. This activity might generate strong economic returns if managed properly (Potts *et al.* 2009).

There is an urgent need to improve fisheries monitoring in Angola as official estimates are unreliable (Lankester 2002) and unreported catches high as shown by the present study. Furthermore, the lack of monitoring, surveillance and control contributes to the increasing pattern of illegal fishing. Particularly, when the latter is decreasing in the neighboring Namibia as surveillance is at its best.

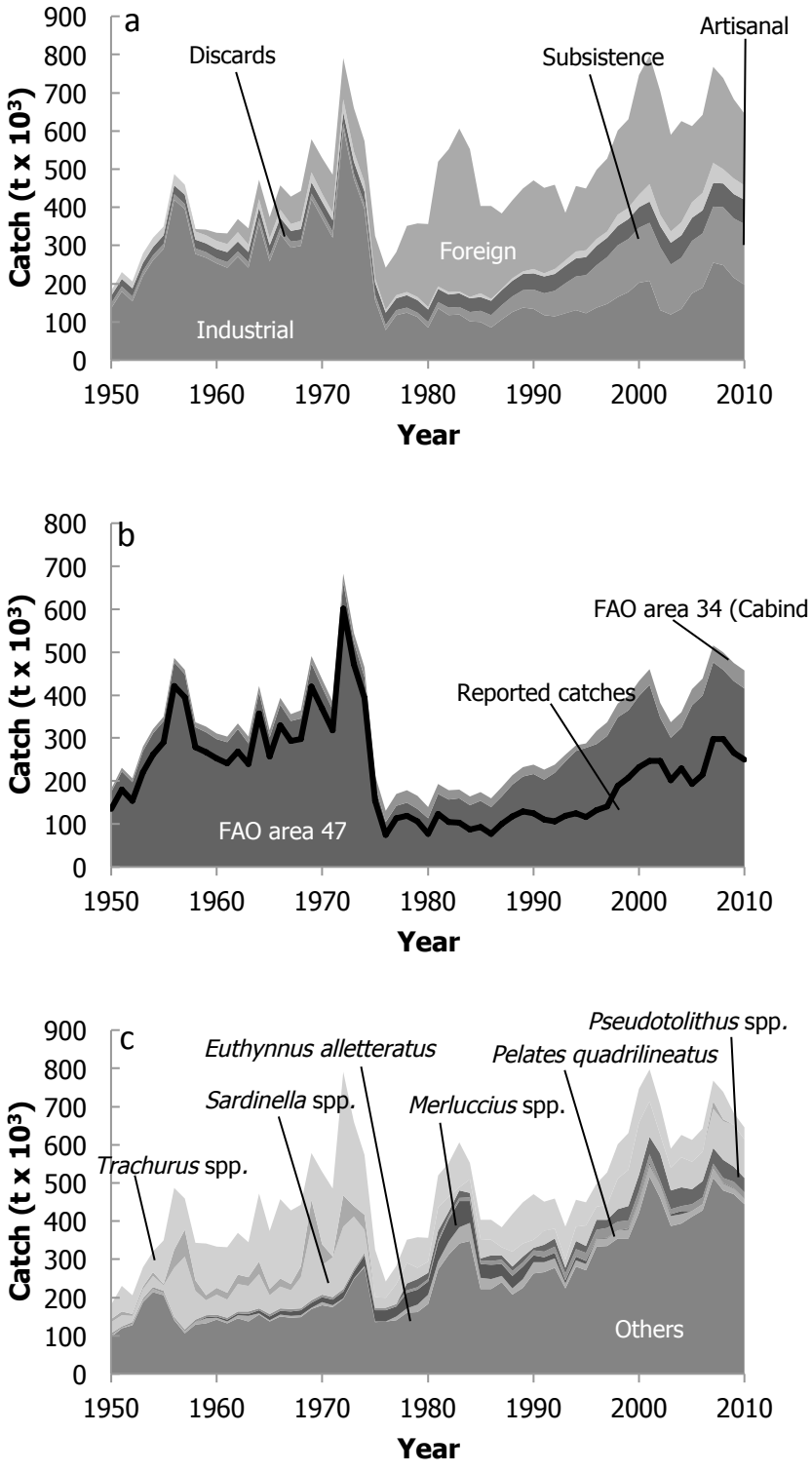

Figure 9. Total reconstructed catches from the Angolan EEZ by a) sector including domestic and foreign catches; b) statistical area including domestic catches; and c) taxon including domestic and foreign catches, 1950-2010. The category 'others' includes over 170 additional taxa pooled here for clarity.

Acknowledgments

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