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ABSTRACT

The marine waters of Senegal are very productive, and thus fisheries have become importance to the economy and food security of local populations in Senegal. Also, Senegalese fisheries resources are exploited by a number of Distant-Water Fleets, both legal (mostly reflagged to Senegal) and illegal. Illegal, Unreported and Unregulated (IUU) fisheries in Senegal, however, have never been formally estimated, nor examined from a historical perspective. Herein, IUU catches along the Senegalese coast between 1999 and 2011 were estimated for the first time at 2.6 million t. Legal catches by the industrial fleets reflagged to Senegal accounted for 1.7 million t between 1999 and 2011, three times the landings reported in the official reports of the Senegalese 'Département des Pêches Maritimes', and are presently stagnating. Illegal fisheries, on the other hand, which totalled an estimated catch of 714,000 t from 1996 to 2011, are steadily increasing. This increasing trend, besides implying a huge loss of potential revenue, threatens the food security of local populations in West Africa, many of them heavily relying on Senegalese seafood as a primary source of animal protein.

INTRODUCTION

Senegal is located in Northwest Africa (Figure 1), and borders Mauritania from the North, Guinea

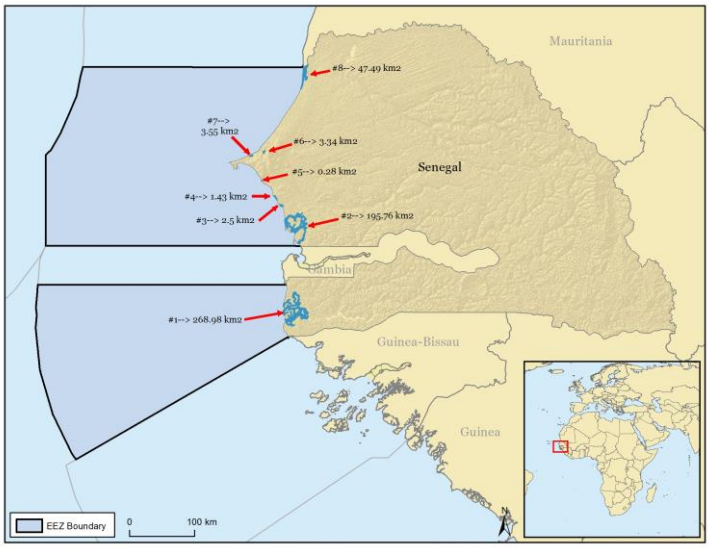

Figure 1. Map of Senegal showing the Exclusive Economic Zone and some coastal lagoons

Bissau and The Gambia from the South, and the islands of Cape Verde from the west. Senegal has one of the most important artisanal fleets of West Africa, with around 20,000 *pirogues*. Similarly, this country's Exclusive Economic Zone (EEZ) is one of the most exploited in West Africa in terms of industrial fishing, both by foreign fleets, and fleets reflagged to Senegal. Senegalese fisheries generate over 280 million $US annually, and provide jobs for one out of six Senegalese (Greenpeace 2012). Indeed, the large EEZ (159,000 km^2), including highly productive waters enriched by a seasonally strong upwelling, and an ever-increasing international demand for seafood have attracted the Distant-Water of several countries, operating under different kinds of access agreements, or simply operating without authorization from Senegalese authorities, i.e., illegally. Not surprisingly, when such operations are coupled with a poor monitoring capacity by the host country, including an inability to regulate quotas (Pramod and Pitcher 2006), it is difficult to assess the impact of these fleets on local stocks and economy. However, there are hints which help understand the dynamics and the extent of this impact. In 50 years, the number of legal industrial vessels grew by a factor of 22 from 1960 to the late 1990s, then decreased to a third in less than 10 years (Bonfil *et al.* 1998; DPM 2011), while still remaining very high. More recently, after 1996, observers were no longer admitted onboard Senegalese flagged vessels (Pramod and Pitcher 2006), which has most likely encouraged reflagging practices, and the 'senegalization' of fishing access agreements, under which observers were mandatory, to joint venture reflagging (Niasse and Seck 2011). Lack of observers generally produces unreliable catch data, especially when these vessels often land their catches in countries others than the ones in which they fish (Pramod and Pitcher 2006). Evidence of illegal practices by these vessels (UNEP 2004) supports the suggestion that relying only on a catch inspection scheme is not very effective. Indeed, some authors concluded that even with observers onboard, the Senegalese authorities struggled to ensure effective control of legal foreign fleets, including those from EU countries (Kaczynski and Fluharty 2002; Witbooi 2008).

While the legal foreign fishery has declined in the last 20 years (i.e., Russian vessels were asked to leave and EU-Senegal agreements cancelled), continued over-exploitation of the Senegalese fishery resources, all the way to the commercial extinction of some species (Pramod and Pitcher 2006) suggests high, and increasing unrecorded catches by foreign vessels. Numerous accounts by fishers and official reports document illegal vessels of different origins (Vidal 2012). Illegal fishing and unregulated fishing by legal industrial reflagged fleets are known to compete with the artisanal fisheries (Vidal 2012), and thus create conflicts with the local population.

Thus, the problem is that, in one hand, Senegal is reflagging foreign vessels called `charters', which have a majority Senegalese ownership that is often nominal (Niasse and Seck 2011), while, on the other hand, Senegal owns a huge domestic artisanal fleet, which ought to be reduced because of overcapacity (Ferraro and Brans 2009). Frequent incursion by industrial fishing vessels into designated artisanal fishing zones and a large number of artisanal *pirogues* fishing beyond the limits of these legally established zones (Deme and Dioh 1994; Diallo 1995; Binet *et al.* 2012) (Pramod and Pitcher 2006; Greenpeace 2012), suggest the latter remain aspirational, which causes widespread conflicts. Moreover, Senegal is in the unique situation that neighbouring countries are heavily dependent on seafood supplied by the Senegalese

artisanal fleet, while Senegalese fishers are increasingly dependent on the resources in these neighboring countries for their catches (Niasse and Seck 2011).

Under these conditions, and given the possible impacts of illegal and unregulated activities in Senegalese waters, it is justified to estimate Senegalese illegal and unreported catches, instead of simply assuming them to be low (MRAG 2005; Pramod and Pitcher 2006).

METHODS

In the present work, we attempt to quantify the catch (including discards) of illegal fishing (i.e., by unauthorized foreign vessels), and unregulated and unreported fishing by domestic industrial fleets suspected of regular transhipping. First, we estimated the catch per unit of effort (CPUE) per vessel, by country (or region) of origin of the fleet. Then, using the estimated number of vessels in operations (illegal and legal), we estimated the illegal catch and the unreported unregulated catch by the fleets authorized to operate in Senegal. Discards were then estimated for each fleet segment.

Catch per Unit of Effort (CPUE)

We conducted a survey from the August 22 to September 5, 2012 at the most important fishing and landing harbour in Senegal (Dakar), where most industrial vessels land their catches. Twenty-five skippers representing a quarter of the fleet were randomly selected and interviewed under promise of anonymity. The sample covers vessels fishing in all industrial fishing zones of Senegal (North, South and Central Senegal) and the major targeted sectors, i.e., tuna, other fish and shrimp. These surveys had four major goals, i.e., to (1) identify issues around illegal fishing (2) identify the frequency of illegal activities observed by the skippers while at sea; (3) analyze the real (i.e., beneficial) ownership of the vessels via the nationality of the crew and/or skipper and (4) estimate catch per unit of effort (Appendix table A1).

On the other hand, the average daily catch was estimated at 50 t·vessel^{-1} based on reported landings and the number of days for the Russian vessels during the pelagic campaign 2011-2012, surveyed by the *Direction de la Surveillance et de la protection de la pêche* (DPSP, Department of surveillance and protection of fisheries) (Appendix table A1).

The first step in estimating the CPUE was to determine the unit of effort. Since the effort description for illegal vessels is rarely available, we used the list of licensed vessels in Senegal from (www.dpm.sgn [2013]; www.dpsp.sn [2013]) to analyze the profile of vessels operating off Senegal.

We searched for the registration number of each vessel and/or the name in the online databases www.maritime-connector.com [2013], www.marinetraffic.com [2013], www.vesselfinder.com [2013] and www.grosstonnage.com [2013], and search for the last reported owner (by default the seat of the company managing the vessel), the former flag history and the GRT of each vessel documented. Based on each vessel's management and the history of its reflagging, we then inferred the origin and suspected ownership for all vessels (Appendix table A2). The main goal behind this exercise is to determine the GRT profile, by country of origin, of the industrial fleet

operating in Senegalese waters. Indeed, in Senegal, most industrial vessels over 20 m are of foreign origin operating under joint ventures, reflagged, or operating under access agreements. We identified six categories based on their inferred origin and GRT, and estimated the average GRT for each category by dividing the sum of the GRT for each category by the number of vessels from the same category (Table 1).

Herein, the CPUE is calculated as the daily catch for each unit of capacity (in $t \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$) that characterizes vessels from each fleet (by origin, Table 1). As suggested by Goffinet (1992) and Johnstone (1996), this measure is appropriate if we assume that fishing vessels would always tend to maximize their catch. The second step was then to establish an optimal CPUE using a Monte-Carlo method. The Monte-Carlo method allows generating the solution (herein the optimal CPUE), many times (10,000 times) by randomly choosing values from the probability distribution of the parameters, here ranging between a predefined maximal and minimal CPUE. The result is an optimal CPUE and an estimate of the uncertainty associated to it (Pauly *et al.* 2013).

Minimal CPUE

Herein it is reasonable to assume that the minimal CPUE would be that whose estimation is based on the officially reported catch, i.e., 50 $t \cdot vessel^{-1} \cdot day^{-1}$ for Russian vessels of an average GRT of 6,560 (Table 1). Therefore by dividing the daily catch by the average GRT, we obtained a CPUE of 7.6 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$ set as a minimum in the Monte-Carlo model.

Maximal CPUE

Maximal CPUE is a difficult parameter to estimate as it sets the upper limit of unreported catches; therefore, it was based on several sources. While reported landings represent the portion of the catch declared by each vessel, Greenpeace (2012) reported that the catch by foreign (e.g., Russian) vessels could be as high as 250 $t \cdot day^{-1}$. The CPUE was then calculated at 38.1 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$. On the other hand, demersal Chinese vessels catch around 1,200 $t \cdot year^{-1} \cdot vessel^{-1}$ for a GRT of 308 and 313 fishing trips (DPSP 2012), i.e., 12.44 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$. Finally, ter Hofstede and Dickey-Collas (2006) observed a daily catch of 102.32 $t \cdot \cdot day^{-1} \cdot vessel^{-1}$ onboard Dutch pelagic trawlers for a GRT of 6,534, i.e., 15.65 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$. We averaged the three estimates and obtained a maximal CPUE of 22.06 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$.

With a CPUE of 7.6 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$ as lower bound and a CPUE of 22.06 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1}$ as upper bound, the Monte-Carlo method allowed estimation to estimation of an optimal CPUE of 14.78 $kg \cdot GRT^{-1} \cdot day^{-1} \cdot vessel^{-1} \pm 4.2$.

We obtained to total daily CPUE by multiplying the CPUE per GRT by the average GRT for each fleet segment, where the 'segments' are the country of origin of the reflagged vessel investigated previously (Table 1).

Table 1. Suspected origin of vessels operating in Senegal including the domestic and foreign fleets, their average GRT and the corresponding CPUE for 2011.

Origin	Number of vessels[a]	Average GRT per Vessel	CPUE ($t \cdot vessel^{-1} \cdot day^{-1}$)
Western Europe	39	240 ± 27.12	3.64
Senegal	18	180 ± 29.86	2.74
Russia	0[b]	6,560 ± 1439.64	96.98
China	14	308 ± 21.97	4.55
Africa and FOC	2	225	3.33

a) Only vessels whose flag we could identify were taken into consideration, i.e., 66% of the so-called Senegalese fleet;
b) Although absent in the actual datasets of the *Département des pêches maritimes* (DPM, Department of fisheries), the need to establish a GRT profile to estimate past catches of Russian vessels in herein highlighted.

Estimation of the Illegal effort and illegal catches

Illegal fishing, defined as a crime by INTERPOL (2010), is a fishing activity conducted in waters under a national jurisdiction, but for which a foreign vessel does not hold an authorisation of any kind. This, in the present study, would exclude any activities by domestic and authorized fleets that would be considered illegal under Senegalese law (fishing with un-authorized gear, fishing in prohibited zones etc. by the authorized fleets), these activities are rather considered unregulated. Also, catches of the domestic industrial fleet under 20 m would be already included in the statistics.

Illegal fishing effort in Senegalese waters is mostly occurring in form of incursions by foreign vessels legally or illegally operating in the waters of neighbouring countries (e.g., Russian vessels authorized to fish in Mauritania and operating illegally in Senegal from December to May, i.e. 150 days, which correspond to the North-South migration of *Sardinella* spp. and other small pelagics (Deme *et al.* 2012). Thus, vessels from Russia, Belize (FoC) and Panama (FoC) perform their incursions into Senegalese waters from the north (i.e., Mauritania), while Japanese, Chinese and Korean vessels, and from other FoC and European countries do this from the south (Gaudin and Groupement GOPA consultants 2011) , where monitoring and control are absent for 305 days per year. Their GRT varies from 1,000 to 7,000 GRT (Gaudin and Groupement GOPA consultants 2011).

A list of these suspected vessels along with their origin was established through direct inspections and observations by the DPSP during the 2012 African Maritime Law Enforcement Partnership (AMLEP) operation from June 16th to July 07th, as well as a direct survey addressed to vessel owners alluded above, and summarized in Table 2.

Table 2. Number of suspected/ illegal vessels per flag of origin.

Flag	Russia	Europe	FoC[a]	Total
Observed vessels	9	7	20	36
Percentage (%)	25	19	56	100

a) Mainly Chinese vessels based in Guinea-Bissau and Guinea (Anon. 2013).

The information above, which draw a clear picture of the profile of illegal vessels and their origin, covers only part of the illegal fishing fleet operating in the Senegalese EEZ. Based on an estimated 5 incursions per month by different vessels (Jibril

Jawara, Operation Manager, DPSP, per. comm.), we estimated a total of 60 incursions by different vessels per year. We allocated these vessels per flag of origin using the percentage of incursions per flag (Table 2) and identified a more realistic number of vessels responsible for illegal fishing in the Senegalese EEZ. We multiplied the percentage of contribution of each flag (Table 2) by the total number of vessels (60) and, using the estimated the number of vessels per country per origin (Table 3), we multiplied the CPUE per day by the number of days, then by the number of vessels, and thus obtained the total illegal catch for 2011, by country.

Table 3. Estimation of the annual illegal catch per vessel origin from the Senegalese waters in 2011.

Flag	**Russia**	**Europe**	**FoC (China)**	**Total**
Estimated number of vessels	15	12	34	61
Number of fishing days	150	305	305	-
CPUE ($t \cdot vessel^{-1} \cdot year^{-1}$)	14,547	1,110	1,016	-
Annual catch ($t \cdot year^{-1}$)	218,211± 1,204	12,152 ± 67	34,495 ± 190	264,858 ± 1,461

Change through time

The percentage of illegal fishing over total fishing activities was estimated for different years by different sources (Table 4). MRAG (2005) estimated IUU fishing activities in Senegal to be 8% of the total catch, while Kelleher (2002) estimated the total number of infractions to be 1% of the total fishing activities in 1996, 4% in 2000, and 9% in 2001. Although the latter observations were based on aerial surveys, these were occasional (due to limited funding) and covered only a small time period, and therefore could not be used here. On the other hand, data by the DPSP, shows the number of observed vessels involved in illegal activities, and the number of vessels licensed to fish within Senegalese waters, which allowed estimating the fraction f illegal activities over total fishing activities as a proxy to illegal fishing in Senegal from 2002 to 2011 (Table 4).

When numbers were inconsistent (e.g., when the same vessels were inspected and/or arrested several times, which leads to the number of inspections being lower than the number of vessels arrested), they were replaced by another proxy. Thus, for example, when the ratio vessel arrested/vessel inspected was not available, we used the ratio vessel arrested over the total number of authorized vessels. Based on this, we estimated the change in illegal fishing (Vi)from year (t+1) to year (t) using the formula: $Vi = [(Illegal_{t+1}-Illegal_t)/Illegal_t] \times 100\%$. We then applied this variation to illegal catches in 2011, 2011 being the baseline, backwards and obtained a time-series for illegal and unreported catches from 2000 to present.

Unreported catches by industrial fleets flagged to Senegal

Three transhipments of catches in the Senegalese EEZ were observed over a period of two weeks during the AMLEP surveys, which illustrates the extent of these operations. These transhipments were conducted by vessels authorized to fish in Senegalese waters, and thus it is reasonable to assume that transhipped catches were from the Senegalese EEZ.

Table 4. Historical variation of illegal fishing in the waters of Senegal from 1996 and 2011 from DPSP and Senegalese Navy, (unpub. data.).

Year	Authorized vessels	Inspected vessels	Arrested vessels	Arrested/Inspected (%)	Arrested/authorized (%)	Annual variation (%)
2000	270	-	-	-	4[a]	1.30
2001	243	-	-	-	9[a]	0.50
2002	159	-	21	-	13.2	-0.17
2003	221	-	24	-	10.9	-0.39
2004	195	-	13	-	6.7	2.13
2005	174	103	22	21	12.6	-0.41
2006	155	7[b]	19[b]	NA	12.3	0.23
2007	132	0[b]	21[b]	NA	15.9	-0.43
2008	107	90	8	9	7.5	0.40
2009	119	206	15	7	12.6	1.00
2010	118	61	15	25	12.7	-0.24
2011	113	95	18	19	15.9	Base

a) Kelleher (2002);
b) The number of inspected vessels was higher than the arrests, and thus was not used.

To estimate the segment of catches unreported under transhipments, we used the previous CPUE estimates per GRT per vessel per country of origin (Table 1), the number of fishing days per country of origin and the number of industrial vessels authorized to operate in Senegal from the DPM and DPSP reports (Table 5).

In the present study, only the vessels for which information could be found in the vessel databases cited above could be identified and taken into consideration, i.e., 73 over a total of 113 vessels with a Senegalese flag (65%). We further investigated the origin of some vessels; for example, using the databases mentioned above, we could identify only 5 Chinese vessels reflagged to Senegal, whereas other references (MEGAPESCA 2003; Auregan 2007; Mallory 2012; Vidal 2012) identified the Senegalese *Sénégal Pêche* as a subsidiary of China's *National Fisheries Corporation*, the largest fishing company in Senegal, which owns 12 to 14 industrial trawlers. Therefore, since the rest of the fleet is considered Senegalese, and their landings were not re-estimated, our estimate is likely conservative.

Table 5. Origin of vessels disaggregation per year.

	Senegal	China	Russia	FoC and Africa	W. Europe
Percentage of each origin	24%	19%	0%	3%	53%
Number of fishing days	167	313	230	330	318
Reference	DPSP (2012)	DPSP (2012)	FAO (2003)	DPSP (2012)	DPSP (2012)
1999	42	33	2	5	92
2000	42	34	2	5	94
2001	39	31	2	4	85
2002	36	28	2	4	78
2003	33	26	2	4	74
2004	32	25	2	4	70
2005	26	21	2	3	57
2006	32	25	2	4	71
2007	29	23	2	3	63
2008	22	17	1	3	49
2009	21	16	1	2	46
2010	20	16	1	2	45
2011	42	33	2	5	92

Discards

Discards by the industrial sector in West Africa are high. This is particularly true for Senegal, especially by the demersal sectors (Emanuelsson 2008). In Senegal, the two main industrial fishing sectors generate relatively large amount of discards. These are documented in the literature as percentage of the total catch, i.e., total catch = landed catch + discards.

Demersal trawl discards

Kelleher (2005) estimated Senegalese demersal trawl discards at 62% of total catches for 2000, which means the discarded catch was 1.6 times the landed catch. Emanuelsson (2008) estimated discards at 43% of total catches for 2005, i.e., discarded catches were equivalent to 74% of landed catches (Table 6). Emanuelsson (2008) suggested that discards were decreasing because of increasing retention of the bycatch. Thus, we extrapolated the trend from 2000-2005 to 2011 and estimated a discard rate of 37% in 2011 (when discards were equivalent to 62% of landed catches). We then interpolated linearly discard rates per year to bridge the anchor points (Table 6).

Table 6. Discard rate and contribution of the demersal trawl sector to total catches. Interpolations are italicized.

Year	Discard rate (%)	Reference
2000	62	Kelleher (2005)
2001	*58*	-
2002	*54*	-
2003	*50*	-
2004	*47*	-
2005	43	(Emanuelsson 2008)
2006	*42*	-
2007	*41*	-
2008	*40*	-
2009	*39*	-
2010	*38*	-
2011	*37*	Estimated by carrying the trend 2000-2005 forward.

Assuming that illegal operation generate the same amount of bycatch, we multiplied the illegal demersal illegal catches (i.e., the illegal catches of the EU fleets) by the estimated discard rates, and thus obtained the discards of the illegal demersal fleet.

Similarly, we multiplied our estimated discard rates by the annual catch of the domestic demersal trawler fleet. (The domestic demersal fleet is not really Senegalese; most of the Senegalese vessels are small-pelagic purse seiners).

Pelagic trawl discards

To estimate pelagic trawl discards, we used the discard rate provided by ter Hofstede and Dickey-Collas (2006) for pelagic Dutch trawlers in Mauritania, which is based on at-sea observations, i.e., 11% of the total pelagic catch of European pilchard (*Sardina pilchardus*), jack and horse mackerels (*Trachurus* spp.) and sardinella (*Sardinella* spp.). Thus, the discarded catch was equivalent to 12% of the landed catch of these species. We assumed the profile of pelagic trawl discards was homogenous for all foreign fleets, since most illegal pelagic catches were performed by vessels coming

from Mauritania (see above). Therefore, we applied the previous discard rate by 94.6% of the pelagic trawl catch, 94.6% being the percentages of the contribution of European pilchard, jack and horse mackerels and sardinella to total catches (ter Hofstede and Dickey-Collas 2006).

Discards of the Senegalese purse-seine fleet, which target small pelagic fishes are considered negligible (Moustapha Deme, CRODT, pers. comm.), and therefore not considered here. Furthermore, on-site observations indicate that, as is the tradition in West Africa, these vessels increasingly sell their low-commercial value bycatch to artisanal fishers.

Sensitivity analysis of illegal catches

Given the furtive nature of illegal fishing, and the assumptions that are involved in its quantification, a sensitivity analysis is conducted here to gain insights into which of these assumptions are most critical, and how they affect the total estimated illegal catch. The CPUE estimated here is optimized based on a robust Monte-Carlo model that re-estimated the latter 10,000 times, which at the end resulted in a reasonable CPUE that fits observations and trends in the literature (e.g. Caverivière and Rabarison Andriamirado 1988). Similarly, the GRT estimated is based on observed effort data collected from different sources. Consequently, the two parameters that draw our attention were the number of fishing days and the number of incursions, i.e., vessels per month. While the latter (5) is based on the observations of the DPSP over 15 days of monitoring, it is reasonable to assume that the minimum number of incursion would not be lower than 4 vessels per month (-20%), as incursions are observed frequently, and over 6 vessels per month (+20%).

We also set the number of days at a minimum of -40% the current value and a maximum of +10% the current value. The number of days cannot be higher, as this would imply that illegal vessels operate all year long in Senegal. The number of days can hardly be lower than the minimum value set for the sensitivity analysis, given that pelagic trawl vessels (for example) follow migrations of small pelagic fish, which implies that their presence in the neighbouring countries would be economically beneficial only if (a) these vessels stopped operating during the time period where fish is migrating south, or (b) their fishing activity continues in the south (i.e., Senegal). These scenarios allow assessing the effect of two variable on illegal catches (Table 7).

Table 7. Parameter changes used in the Sensitivity Analysis.

Scenarios	Number of incursions (%)	Number of days (%)	Note	Change in catch (%)
Scenario 1	20	10	more vessels more days	32
Scenario 2	-20	10	Less vesels more days	-12
Scenario 3	-20	-10	Less vessels less days	33
Scenario 4	-20	-20	Less vessels less days	-36
Scenario 5	-20	-40	Less vessels less days	-52
Scenario 6	20	-10	More vessels less days	8
Scenario 7	20	-20	More vessels less days	-4
Scenario 8	20	-40	More vessels less days	-28
Scenario 9	20	0	No change in number of days	20
Scenario 10	0	10	No change in number of vessels	10

Results

Illegal catches

Illegal catches and their corresponding discards were estimated at around 2.6 million tonnes in the period from 2000 to 2011. Illegal catches increased by a factor of 5, after the cancellation of Senegal-Russia agreements in 1999, from about 67,000 t·year^{-1} in 2000 (of which 8,400 t·year^{-1} were discarded) to 400,000 t·year^{-1} in 2010 (of which 46,000 were discarded).

Illegal catches declined in 2011 by around 100,000 t·year^{-1}, after the re-authorization of Russian vessels (Figure 2a).

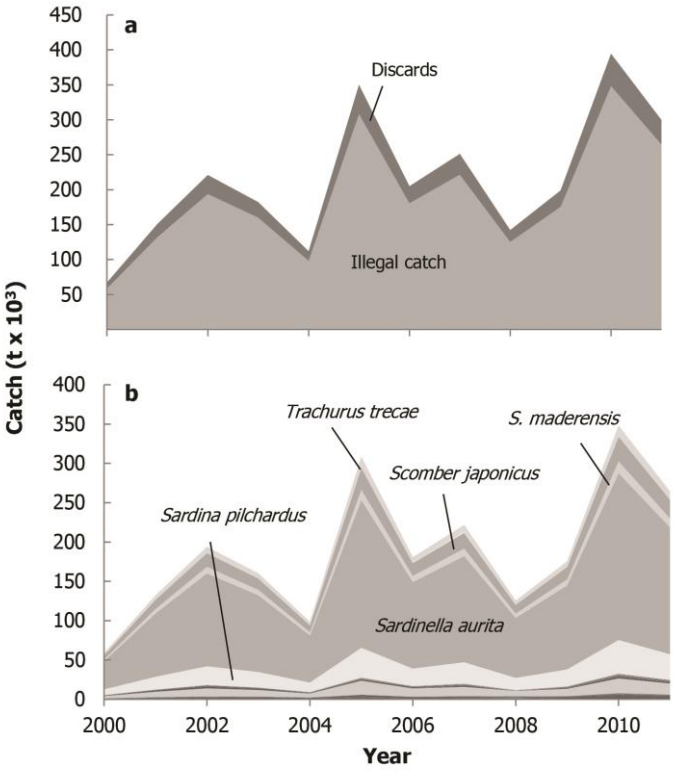

Figure 2. Annual illegal catches and the corresponding discards by Distant Water Fleets from the Senegalese waters a) by sector and b) by taxon, 1996-2011.

Of over 170 taxa identified in Senegalese catches (DPM 1999-2011), catches of sardinella, European pilchard and mackerels dominate illegal catches with over 2 million tonnes between 2000 and 2011, i.e., 39,000 t·year^{-1} annually (Figure 2b).

Domestic industrial catches by the fleet (re-)flagged to Senegal

Industrial catches by the fleet flagged or reflagged to Senegal were estimated at 1.5 million tonnes between 2000 and 2011, compared to 572,000 t in official reports of the DPM during the same period, i.e., 1 million tonnes went unreported. Catches decreased overall from around 179,000 t·year^{-1} in 2000 to a minimum of 75,000 t·year^{-1} in 2011 (Figure 3a). Re-estimated landed catches were herein twice to 4 times the reported catches to the DPM (Figure 3a). However, the under-reported component was higher in the early 2000s, when the re-estimated catch was over 3 times the reported catch on average, and decreased gradually to less than 2.2 times the reported catch in the late 2000s, which implies improvement in reporting (Figure 3a).

Discards on the other hand, were estimated at 633,000 tonnes between 2000 and 2011, which is the equivalent of 42% of the industrial retained catch by the fleet flying the Senegalese flag. Discards show a declining trend overall between 2000 and 2011 from 100,000 t·year^{-1} to 25,000 t·year^{-1} respectively, which is also applies when comparing the rate of discards, 55% of retained catches in 2000, with that in 2011, i.e., 14% (Figure 3a).

The retained catch includes many taxa; however, demersal species such as soles (*Cynoglossus* spp.), bigeye grunt (*Brachydeuterus auritus*) and octopus (*Octopus* spp.) and carangids dominate the catch, which further illustrates the predominance of a demersal Senegalese industrial fleet (Figure 3b).

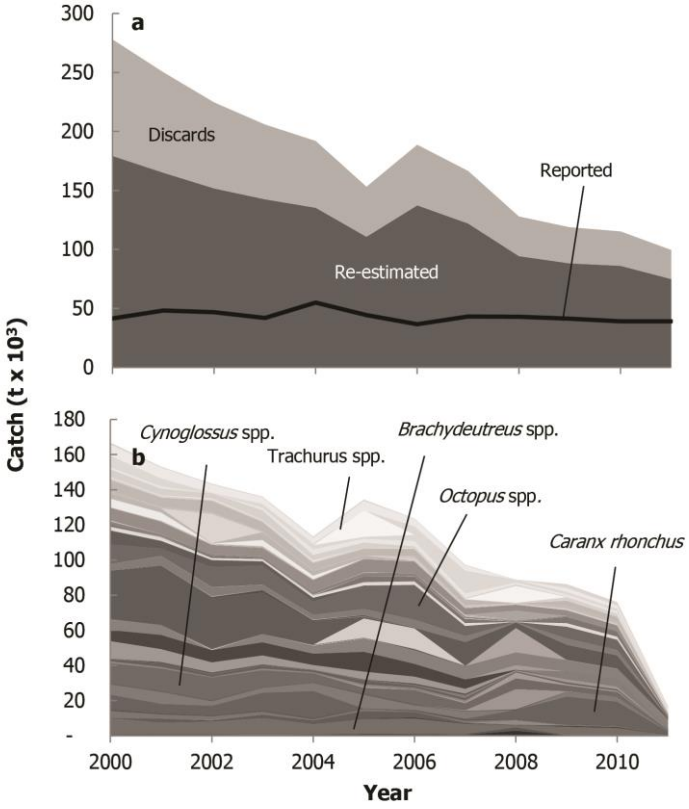

Figure 3. Estimated total catches by the legal domestic fleet of foreign origin from the Senegalese waters and their corresponding discards a) compared to the industrial landing data supplied by DPM, and b) by taxon, 1999-2011.

Discards

Total discards were for both the legal and illegal sectors were estimated at over 938,000 tonnes between 2000 and 2011, of which 78% was generated by the legal fleet. Illegal fleets operating in Senegal discarded 175,800 t between 1999 and 2011.

Discards decreased from around 107,000 t·year^{-1} in 2000 to 50,000 t·year^{-1} in 2008, and then increased slightly to around 60,000 t·year^{-1} in 2011, mostly due to the high discard rate associated with demersal trawls (Figure 4). Discards generated by the foreign fleet reflagged to Senegal were much higher, with over 633,000 tonnes discarded between 2000 and 2011, compared to 305,000 tonnes by the illegal fleets (Figure 4).

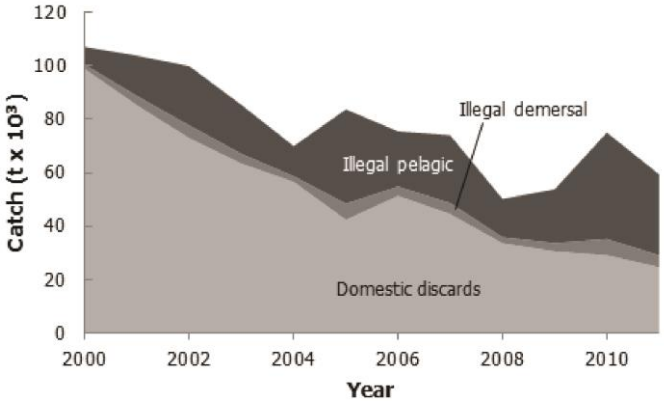

Figure 4. Discards of the demersal and pelagic sectors by sector, 1999-2010.

Total illegal unreported unregulated catches

Total IUU catches, i.e. the sum of illegal catches, unreported catches by the fleet reflagged to Senegal and discards, totalled 4.2 million tonnes between 2000 and 2011. Although IUU catches remained relatively constant over time (Figure 5a), illegal catches are shown to increase in contrast with catches by the legal fleet flying the Senegalese flag (Figure 5b).

Total catches consisted mainly of sardinellas and of demersal species (Figure 5c). Sardinella catches were estimated at 1.6 million tonnes between 2000 and 2011, i.e., 34% of total catches, while the remaining 66% of the catch consisted a large number of taxa (Figure 5c).

Illegal industrial catches of sardinella were earlier equivalent to 20% of the reconstructed artisanal catches, but now, they have increased, and are as high as artisanal catches (Figure 5c).

Jointly, the illegal and legal catches taken from the Senegalese EEZ (see also Belhabib *et al.* 2013) exceed the maximum sustainable yield estimated for Senegal by CRODT (2001), which ranged from 450,000 to 600,000 t·year^{-1} (Figure 6).

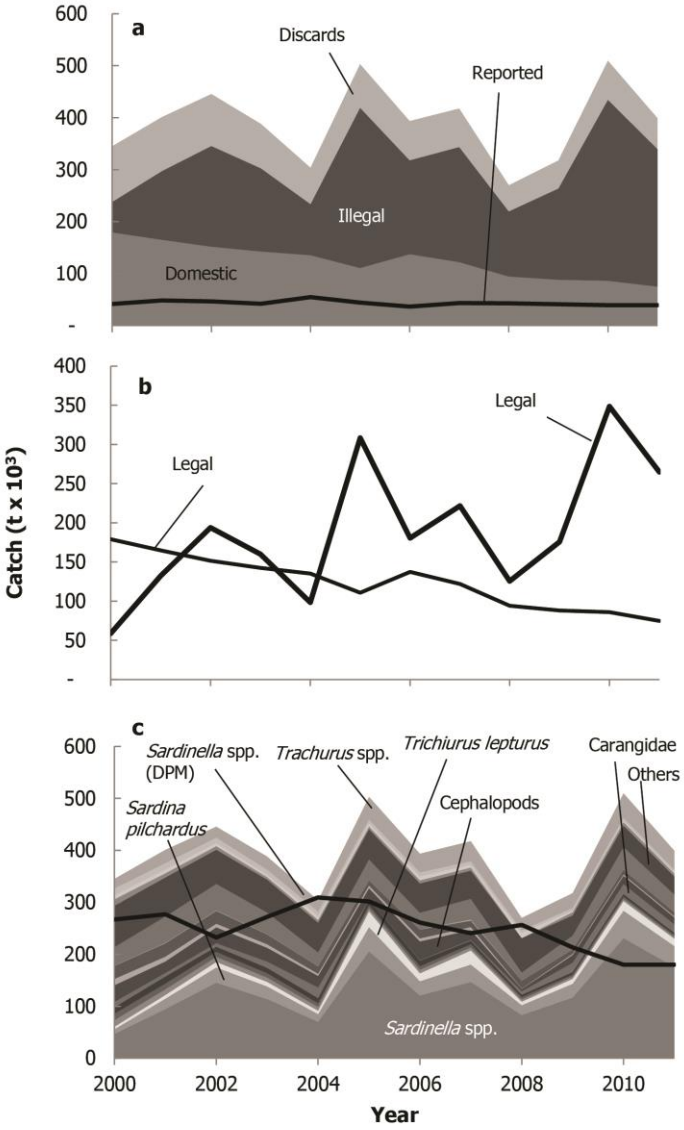

Figure 5. Legal and illegal fisheries in the Senegalese EEZ: a) Total illegal, unreported unregulated industrial catches; b) Comparison of legal and illegal catches; c) Comparison of the illegal catch with artisanal reconstructed catches of sardinella estimated by Belhabib *et al.* (2013), 2000-2011.

<u>Sensitivity analysis for illegal catches</u>

The sensitivity analysis conducted for two of the parameters used herein showed that illegal catches are impacted strongly by the estimated number of incursions, but not the number of days these incursions last. The scenario of Table 7 that drove illegal catches to their highest values was when the number of incursion was 20% higher, i.e., one more incursion per month, along with a 10% increase in the number of

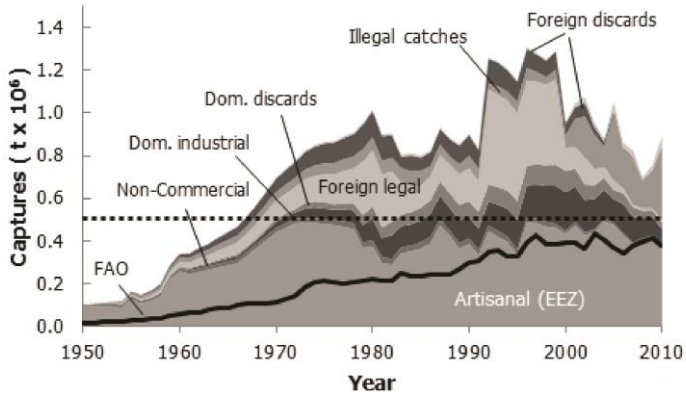

Figure 6. Total catches from the Senegalese waters, 1950-2010. The maximum sustainable yield (450,000 to 600,000 t·year^{-1}) estimated by CRODT (2001) is also shown. 'Non-commercial' refers to recreational and subsistence catches.

days. In contrast, catches were at a minimum of 127,000 t·year^{-1} when the number of incursions was lowered by 20% (to 4 incursions monthly) and the number of days was lowered by 40% (Figure 7). This scenario, although possible, is unlikely, given the low monitoring intensity in Senegalese waters, fish migrations which provides a good incentive for large pelagic trawl vessels to follow them, and a large almost entirely unmonitored continental shelf along with relatively high abundance compared to the southern neighbours of Senegal

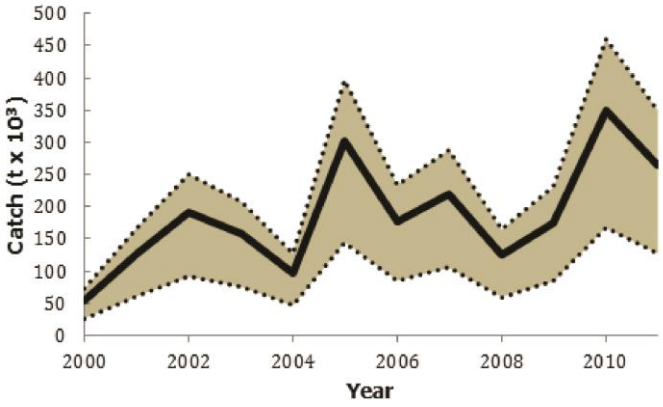

Figure 7. Sensitivity Analysis of illegal catches in Senegal showing the upper and lower boundaries, 2000-2011.

Value of Illegal Unreported and Unregulated catches

Total industrial catches in Senegal and the discards generated were estimated at 412,000 t·year^{-1} in 2011, which when multiplied by the ex-vessel price of catches (on average) estimated at 366 CFAFr/kg (DPM, 2010)[1] would land a total value of $300 million US annually. Illegal catches alone were worth $194 million US ranging between at least $93 million US and $256 million US. The value of the transhipped catch and that of foreign flagged vessels was around $33 million US.

DISCUSSION

This work is the first attempt to estimate the IUU catches by industrial fishing fleets in Senegalese water and their temporal variation, and the countries of origin of the fleets in question. This illegal catches were estimated at around 350,000 t·year^{-1} on average caught by both the illegal fleets and the legal fleet of foreign origin reflagged to Senegal, compared to official figures of 44,000 t·year^{-1} on average during the 2000-2011 time period. When total removals are considered (including both the artisanal and industrial sectors), catches are dangerously above the potential yield estimated for Senegal (CRODT 2001). This endangers not only the already over-exploited stocks of Senegal (Diallo 2000), but also imperils an entire fisheries-based sector of the economy. This is particularly true for the artisanal sector, whose fishing ground overlaps the areas frequented by illegal industrial fishing vessels (Niasse and Seck 2011).

It is evident that the increase in illegal fishing is strongly related to the decrease in the number of vessels of foreign origin authorized to fish in Senegal. This suggests that the fleet formerly authorized to fish in Senegal, and which transferred parts of their operation to neighbouring countries (mainly Mauritania, The Gambia and Guinea-Bissau), also converted itself into an illegal fleet operating in Senegalese

[1] We used a conversion where 1000 francs CFA = $ 2.25 US.

waters. On the other hand, the increase in illegal catches demonstrates the limited capacity for adequate control and monitoring along the Senegalese coast.

The assumptions made herein, and our estimates of illegal catches, are conservative for many reasons, notably because we did not consider numerous undocumented Chinese, Korean and Japanese vessels operating illegally in Senegalese waters. Secondly, the 2010 profile of fishing vessels likely underestimated unreported catches by the reflagged fleet, since vessels reflagged to Senegal in the past (before the expiration of the EU-Senegal fishing agreement in 2006) originated in countries outside of the EU, which would have contributed to the under-estimation of mean GRT and therefore CPUEs. Furthermore, the baseline CPUE used in the present study was conservative. For example, it generated a CPUE of 1,100 t·vessel-1·year-1 for the fleet of Chinese origin, while other estimates using the Monte-Carlo method estimated the average Chinese CPUE in West Africa at 1,252 t·vessel-1·year-1 for the demersal fleet showed higher a higher CPUE for the Chinese demersal trawl fleet (Pauly *et al.* 2013).

The high value of industrial illegal and unreported industrial catches estimated here at around $300 million US annually would justify a rethinking of the monitoring policies of Senegal, which should aim at recovering at least a fraction of these $ 300 million US per year.

The present study highlights the clear conflict between the industrial fleet and the artisanal fleet in Senegalese waters, notably as if affects the species most targeted by the illegal fleets, i.e., sardinella. This, along with increasing artisanal catches from outside Senegal (Belhabib *et al.* 2013) suggests that over-capacity by the artisanal fleet is not the only cause of increasing migrations by fisheries. Rather, our results suggest that the high level of competition for the same resources over the same fishing grounds caused the enormous increase of capacity in the artisanal fleet of Senegal, which then spilled over into the neighboring countries further North and South. This led to a the relationship between the foreign host to Senegalese fishers, which may be have been characterized as 'symbiotic' to turn into a parasitic relationship, which then created conflicts between the domestic sector of the neighbouring host countries and migrant Senegalese artisanal fishers.

Considering the role that foreign fishing plays in these negative developments, we are heartened by the recent decision by the President of Senegal to maintain a ban on fishing for sardinella by Russian vessels. Furthermore, at the time this study was being finalized, Senegal is strengthening its Monitoring, Control and Surveillance capacity by acquiring new efficient monitoring vessels, one of which for the offshore waters of the Senegalese EEZ.

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Appendix Table A1. Estimation of the average CPUE by the fleet landing in Senegal (2011-2012, DPSP 2012).

Vessel name	Departure	Landing date	Landings (t)	Fish meal (t)	Number of fishing days	CPUE ($t \cdot day^{-1}$)
LAZURNYY	03/01/12	24/02/12	819	15	52	15.75
ALEX KOSAREV	13/12/11	26/01/12	1,761	0	44	40.02
KOVAS	29/11/11	09/01/12	2,012	0	41	49.07
KAP BOGOMOLOV	27/12/11	02/02/12	1,704	0	37	46.05
VASILY LOZOVSKY	03/01/12	09/02/12	1,748	0	37	47.24
ADMIRAL STARIKOV	24/11/11	30/12/11	1,849	0	36	51.36
ZAHKAR SOROKIN	20/02/12	27/03/12	1,734	113	36	48.16
ZAMOSKVORECHYE	02/03/12	06/04/12	784	36	35	22.40
CORAL	03/12/11	07/01/12	1,492	0	35	42.62
VOLOPAS	31/12/11	02/02/12	1,588	0	33	48.12
NORDIC (AT HEMPES)	09/03/12	10/04/12	2,215	79	32	69.21
M VERBESKY	02/01/12	01/02/12	1,076	0	30	35.86
KING RAY	02/02/12	03/03/12	1,098	85	30	36.60
OLEG NAYDENOV	30/12/11	28/01/12	1,576	0	29	54.34
ALEX MIRONENKO	12/12/11	09/01/12	924	0	28	33.00
MARSHALL VASILEVSKIY	18/01/12	13/02/12	1,007	0	26	38.73
SOLEY	12/12/11	06/12/12	2,163	0	25	86.52
BALANDIS	06/04/12	01/05/12	804	52	25	32.16
IRVINGA	04/12/11	28/12/11	1,297	0	24	54.04
BLUE WAVE	22/12/11	15/01/12	1,821	0	24	75.87
RIBALKA SEVASTOPOL	09/03/12	02/04/12	1,158,330	56,800	24	75.87
THOR	13/12/11	06/02/12	2,024	0	24	84.33
KING KLIP	21/01/12	14/02/12	1,210	0	24	50.41
KING BORA	14/01/12	06/02/12	1,258	51	23	54.69
KING FISHER	12/12/11	04/01/12	1,646,607	0	23	54.69
GLORIA	14/12/11	05/01/12	1,069	0	22	48.59
KIYEVSKA RUS	23/02/12	12/03/12	1,237	40	18	68.72
KING DORY	16/01/12	03/02/12	1,035	0	18	57.50
Average CPUE						**50.78**
SOLEY	06/12/11	08/02/12	1,584		64	24.75
ADMIRAL STARIKOV	30/12/11	08/02/12	2,263	0	40	56.57
LAZURNYY	24/02/12	04/04/12	853	38	40	21.32
BLUE WAVE	15/01/12	19/02/12	1,525	0	35	43.57
ZAHKAR SOROKIN	27/03/12	30/04/12	987	97	34	29.02
CORAL	07/01/12	10/02/12	1,428	0	34	42.00
MARSHALL VASILEVSKY	13/02/12	16/03/12	1285	38	32	40.15
KING FISHER	04/01/12	31/01/12	1,660	0	27	61.48
KING KLIP	14/02/12	10/03/12	1,233	169,4	25	49.32
VASILY LOZOVSKY	09/02/12	04/03/12	849	59	24	35.37
GLORIA	05/01/12	28/01/12	1,276	0	23	55.47
OLEG NAYDENOV	28/01/12	19/02/12	1,552	25	22	70.54
KING DORY	03/02/12	25/02/12	848	34,6	22	38.54
KAP BOGOMOLOV	02/02/12	23/02/12	1,347	28	21	64.14
IRVINGA	28/12/11	18/01/12	826	0	21	39.33
KIYEVSKA RUS	12/03/12	02/04/12	1,011	30	21	48.14
VOLOPAS	02/02/12	18/02/12	452	29	16	28.25
KING RAY	03/03/12	19/03/12	556	29	16	34.75
NORDIC (At Hempes)	10/04/12	24/04/12	458	16	14	32.71
M VERBESKY	01/02/12	15/02/12	1,297	0	14	92.64
KING BORA	06/02/12	20/02/12	576	31	14	41.14
RIBALKA SEVASTOPOL	02/04/12	10/04/12	163	16	8	20.37
Average CPUE						**44.07**
SOLEY	08/02/12	28/02/12	1,704	0	39	43.00
VOLOPAS	18/02/12	23/03/12	1,050	79	34	30.88
KING RAY	19/03/12	18/04/12	1,207	64	30	40.23
BLUE WAVE	19/02/12	19/03/12	1,714	0	29	59.1
KING FISHER	31/01/12	27/02/12	1,184	68	27	46.35
VASILY LOZOVSKY	04/03/12	28/03/12	1,671	54	24	69.62
M VERBESKY	15/02/12	09/03/12	678	38	23	29.47

Appendix Table A1. *Cont.*						
ADMIRAL STARIKOV	08/02/12	29/02/12	1,546	10	21	73.61
ALEX KOSAREV	16/02/12	08/03/12	1,254	13	21	59.71
GLORIA	28/01/12	16/02/12	1,305	0	19	68.68
KOVAS	03/02/12	21/02/12	672	8	18	37.33
RIBALKA SEVASTOPOL	10/04/12	26/04/12	657	82	16	41.06
THOR	12/03/12	28/03/12	477	0	16	29.81
IRVINGA	18/01/12	02/02/12	1,597	0	15	106.46
KING KLIP	10/03/12	02/04/12	1,158	62	13	89.07
KAP BOGOMOLOV	23/02/12	06/03/12	779	44	12	64.91
CORAL	10/02/12	18/02/12	601	113	8	75.12
KING DORY	25/02/12	04/03/12	303	28	8	37.87
KIYEVSKA RUS	02/04/12	08/04/12	162	9	6	27.00
Average CPUE						**54.17**
KOVAS	21/02/12	29/03/12	1,410	38	37	38.10
ADMIRAL STARIKOV	29/02/12	04/04/12	2,058	62	35	58.80
BLUE WAVE	19/03/12	22/04/12	1,641	34	33	49.70
VASILY LOZOVSKY	28/03/12	29/04/12	1,784	87	32	55.75
CORAL	18/02/12	20/03/12	1,157	88	31	37.32
GLORIA	16/02/12	16/03/12	1,184	28	30	42.28
ALEX KOSAREV	08/03/12	04/04/12	1,586	83	27	58.74
KAP BOGOMOLOV	06/03/12	31/03/12	1,900	50	25	76.00
M VERBESKY	09/03/12	02/04/12	751	29	24	32.50
IRVINGA	02/02/12	25/02/12	986	49	23	42.86
SOLEY	28/02/12	21/03/12	1,730		22	78.63
KING FISHER	27/02/12	17/03/12	690	57	19	36.31
KING KLIP	02/04/12	16/04/12	574	106	14	41.00
KING RAY	18/04/12	30/04/12	461	36	12	41.43
VOLOPAS	23/03/12	03/04/12	373	0	9	41.44
OLEG NAYDENOV		04/04/12	2,059	36		57.19
Average CPUE						**51.98**
Overall average CPUE						**50.25**

Appendix Table A2. Vessels reported by DPM and DPSP, their suspected flags and GRT for 2011-2012.

Vessel name	Vessel flag	Registration	Vessel type	Vessel origin	GRT
ADJA FATOU SAKHO	Spain	DAK 865	Shrimp trawl	-	-
ADJA NDOUMBE II ex. SYLVIE	Senegal	DAK 844	Shrimp trawl	Spain	-
ADRIMEX II	Senegal	DAK 819	Shrimp trawl	Senegal	-
AITA FRAXKU	Spain	SS-1-7-99	Tuna	Spain	-
ALMIRANTE AMADOR FRANCO	Senegal	DAK 958	-	Spain	453
ANTA SARR ex. PUNTAMAR	Senegal	DAK 1131	-	Senegal	198
ASBIYALAHOU	Senegal	DAK 596	Small pelagic	Senegal	-
BADAOUI ex A. Amadou	Senegal	DAK 490	Small pelagic	Senegal	-
BAKURUS	Senegal	DAK 1008	Shrimp trawl	Senegal	249
BATTERIE	Senegal	DAK 753	Shrimp trawl	Senegal	179
BERRIZ SAN FRANCISCO	Spain	SS-1-7/03	Tuna	Spain	241
Betty	Senegal	DAK 706	Shrimp trawl	Senegal	228
CAP ROUGE	Senegal	DAK 427	Shrimp trawl	Senegal	139
CAPO TRAMONTANA	Senegal	DAK 1075	Shrimp trawl	Italy	317
CARVISA DOS	Senegal	DAK 1120	Shrimp trawl	Senegal	235
CHARDON BLEU II	Senegal	DAK 1038	Shrimp trawl	Senegal	-
CHIQUITA	Senegal	DAK 990	Shrimp trawl	Spain	237
CORONA DEL MAR	Senegal	BA 724 048	Tuna	France	370
DAHLIA	Senegal	DAK 781	Shrimp trawl	Senegal	155
DAVID MANSOUR ex MARIE ROSE	Senegal	DAK 1190	Tuna	Senegal	-
DOMENICA MADRE	Senegal	DAK 989	Shrimp trawl	Italy	160
DONAKS	Senegal		Shrimp trawl	Senegal	249
ELODIE/AISSATOU	Senegal	DAK 680	Shrimp trawl	Senegal	120
FATIMA	Senegal		Shrimp trawl	Nigeria	125
FAYAKO	Senegal		-	-	-
Fissel	Senegal		Shrimp trawl	Spain	314
GAZTELUGAITZ			Surrounding nets	Spain	155
GOBER CINCO			-	Spain	225
GUEREO			Shrimp trawl	France?	122
HELENE	Senegal	DAK 764	Shrimp trawl	Belgium	292
HISPASEN II	Senegal	DAK 1048	Shrimp trawl	Spain	266
HISPASEN 6	Senegal	DAK 1196	Shrimp trawl	Spain	287
HISPASEN IV	Senegal	DAK 1181	Shrimp trawl	Spain	299
HISPASEN V ex. SORAYA II			-	-	-
ILE AUX FEES			-	-	-
ILE AUX MIMOSAS			-	-	-
ILE AUX OISEAUX			-	-	-
ILE DE CARABANE	Senegal	DAK 527	-	Italy	146
IRIBAR ZULAIKA	Spain		Surrounding nets	Spain	252
ISA	Senegal	DAK 699	Shrimp trawl	Spain	116
JEANE HELENE	Senegal	DAK 992	Shrimp trawl	France	160
KANBAL II	Senegal	DAK 1096	Shrimp trawl	spain	365
KANBAL III	Senegal	DAK 1115	Shrimp trawl	Spain	284
KENTIA	Senegal	DAK 1108	Shrimp trawl	-	120
KERMANTXO	-	-	Pole and Lines	Spain	262
KHADIMOU RASSOUL	-	-	-	-	-
KING CRAB	-	-	-	-	-
KOLLARE	Senegal	DAK 1127	Shrimp trawl	Spain	365
LAGHEM I	Senegal	DAK 1130	Shrimp trawl	Spain	359
LAURENCE MARIE	Senegal	DAK 670	-	Senegal	119
LIO I	Senegal	DAK- 1143	Shrimp trawl	China	293
LIO II	Senegal	DAK- 1144	Shrimp trawl	China	293
LOBELIA	Senegal	DAK 715	Shrimp trawl	Senegal	156
LOUBNA	-	-	-	-	-
MANDIUS 1 ex. PETIT	-	-	-	-	-
MARIE JOSEPHE	Senegal	DAK 817	Shrimp trawl	France	256
MARIKA	Senegal	DAK 741	Shrimp trawl	France	150
Mars	Senegal		Shrimp trawl	Russia/Panama	677/325
MARSOR PRIMERO	Senegal	DAK 1061	Shrimp trawl	Spain	387
MOURIDE NDIGUEL	-	-	-	-	251
MOURIDE SADIKH	-	-	-	-	-

Appendix Table A2. *Cont.*

NATA	Senegal	DAK 1137	Shrimp trawl	Spain	138
NDEYE MARIEME	Senegal		Shrimp trawl	Senegal	198
NIAM NIOKHO	Senegal	DAK 698	Shrimp trawl	France	228
NIKOLAOS K	Senegal	DAK 909	-	Greece	130
NUEVO NOSO LAR	Senegal	DAK 1133	Shrimp trawl	Spain/Portugal	294
NUEVO SAN LUIS	Spain	-	Shrimp trawl	Spain	116
NUOVO EURIPIDE	Senegal	-	-	Italy	317
OCEAN PESCA II	Senegal	DAK 1046	Shrimp trawl	Spain	299
OCEAN PESCA III	Senegal	DAK 1114	-	Spain	349
ONUDAK I/ISLA SALTES I	Senegal	DAK 1021	-	Spain	300
ONUDAK II/ISLA SALTES II	Senegal	DAK 1025	-	Spain	300
ORNON	Senegal	DAK 628	-	-	156
Pape MOUSSA	Senegal	-	-	-	-
PAPMAR ex. PAPE	-	-	-	-	-
PDT MAGATTE AYA DIACK II	-	-	-	-	-
PDT MATAR NDIAYE	-	-	-	-	-
PDT OUMAR DIALLO	Senegal	DAK 755	-	Netherlands	241
PETITE MARILOU	-		-	-	250
PILAR TORRE	Spain	ST-2-4/96	-	Spain	177
RAMATOULAYE	Senegal	DAK 1141	-	-	250
RIA DE DAKAR	Senegal	DAK 1142	-	Spain	157
ROSSO ex. NAVIGANTE			-	-	-
SAFINATOUL AMAN I			-	-	-
SAMIRA			-	-	-
SANTANA ex. ANGE DES MERS			-	-	-
SARAN/MARIE HELENE	Senegal	DAK 506	-	France	106
SEGUNDO SAN RAFAEL	Senegal	DAK 1176	-	Spain	312
SENEMER 14 ex. LES NOURRES II		DAK 697	-	-	-
SENEMER 15		DAK 1109	-	-	-
SERIGNE MOURTADA MBACKE			-	-	-
SERIGNE SALIOU MBACKE		DAK 1057	-	-	-
SOACHIP 12	Senegal	DAK 822	-	China	299
SOLEIL 10 ex SOACHIP 10		DAK 941	-		-
SOLEIL 11 ex SOACHIP XI	Senegal	DAK 821	-	China	299
SOLEIL 51 ex. CNFC 9514	Senegal	DAK 1178	-	China	327
SOLEIL 61 ex. CNFC 9515	Senegal	DAK 1179	-	China	327
SOLEIL 65 ex. YUAN YU 907	Senegal	DAK 1191	-	-	-
SOLEIL 66 ex. YUAN YU 908	Senegal	DAK 1193	-	-	-
SOLEIL 67 ex. YUAN YU 909	Senegal	DAK 1194	-	-	-
SOLEIL 68 ex. YUAN YU 910	Senegal	DAK 1195	-	-	-
SOLEIL 7 ex SOACHIP 7	Senegal	DAK 938	-	-	-
SOLEIL 8 ex SOACHIP 8	Senegal		-	-	-
SOLEIL 9 ex SOACHIP 9	Senegal		-	-	-
SONA	Senegal	DAK 1138	-	Spain	138
TADORNE	Senegal	DAK 602	-	France	228
TATY/SEDAR III/ADELINE	Senegal	DAK 517	-	-	-
TOUBA	Senegal	DAK 995	-	Spain	139
YA FAMA 3 ex. MOUSSA MBAYE	Senegal	DAK 673	-	-	243
YA FAMA II/SAFINATOUL AMAN	Senegal	DAK 518	-	-	243
ZIGUINCHOR	Senegal	DAK 489	-	-	243
ADMIRAL STARIKOV	Russia	8607218	-	Russia	7765
ALEXANDER KOSAREV	Russia	8607153	-	Russia	7765
ALEXANDER MIRONENKO			-	-	-
ATLANTIC HEMPES			-	-	-
BALANDIS	Lithuania	7610440	-	-	5953
BLUE WAVE	Belize	8607191	-	Russia	7765
CORAL V4GV			-	-	-
GLORIA			-	-	-
IRVINGA	Lithuania	8834639	-	Lithuania	4407
KABITAN BOGOMOLOV	Russia	8607402	-	Russia	7765
KING BORA		8033297	-	Ukraine	4378
KING DORI			-	-	-
KING FISHER	St Vinc. & Grenad.	8832112	-	Ukraine	4407

Appendix Table A2. *Cont.*					
KING KLIP	St Vinc. & Grenad.	8721208	-	Ukraine	4407
KING RAY	St Vinc. & Grenad.	8730132	-	Ukraine	4407
KIYEVSKA RUS	Ukraine	8138695	-	Ukraine	4407
KOVAS	Comoros	7610426	-	Poland	5955
LAZURNYY	Russia	8729664	-	Russia	4407
MARSHAL VASILEVSKY	St Kitts & Nevis	8033869	-	Ukraine	4378
MIKHAIL VERBITSKIY			-	-	-
OLEG NAYDENOV	Russia	8607309	-	Russia	7765
RIBALKA SEVASTOPOL	Ukraine	8826151	-	Ukraine	4407
SOLEY	Belize	8607270	-	Russia	7765
STARK	-	-	-	-	-
THOR	-	-	-	-	-
VASILY LOZOVSKY	-	-	-	-	-
VOLOPAS	Russia	6405147	-	Russia	2435
ZAHAR SOROKIN	Russia	8607256	-	Russia	7765
ZAMOSKVORECHYE	Russia	8721129	-	Russia	4407