UPDATING OF TASKS I AND II FOR GHANAIAN INDUSTRIAL TUNA FISHERIES DATA 2006-2012

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SUMMARY

Information available from different sources was used to estimate the tasks I and II for the Ghanaian tuna baitboats and purse seiners during 2006-2012. First, catch and landing data collected and managed by the Marine Fisheries Research Division (MFRD) of Ghana were described and compared with tuna quantities landed in Tema for processing at the Pioneer Food Cannery (PFC) Ltd. Some landings from a few Ghanaian vessels were found to be lower than sold to the cannery, resulting in an annual underestimation of about 2,000-4,000 t during 2009-2012. Information collected on landings of tuna destined to the local market of Abidjan also pointed out that some amount of catch was missing from the MRD database. The synthesis of all data available resulted in a proposal of new total nominal catch for the Ghanaian fleets that exceeded the current ICCAT Task I by about 20%. In a second step, the total catch was distributed in time (month) and space (5° by 5° squares) based on a few assumptions stemming from the available information. Finally, size samples available from the European purse seine fishery on fish aggregating devices were used to estimate the species and size composition of the catch based on a post-stratification of the EU sampling design. Estimates of the size structure of the skipjack catch were made available for the 2014 stock assessment.

RÉSUMÉ

Les informations disponibles provenant de différentes sources ont servi à estimer les Tâches I et II des canneurs et senneurs thoniers ghanéens entre 2006 et 2012. Tout d'abord, les données de capture et de débarquement collectées et gérées par la Division de la recherche sur les pêches marines (MFRD) du Ghana ont été décrites et comparées aux quantités de thons débarquées à Tema pour y être traitées à la conserverie alimentaire Pioneer (PFC) Ltd. Certains débarquements de quelques navires ghanéens se sont avérés être inférieurs aux quantités vendues à la conserverie, ce qui entraîne une sous-estimation annuelle d'environ 2.000 à 4.000 t entre 2009 et 2012. Les informations recueillies sur les débarquements de thons destinés au marché local d'Abidjan ont également souligné qu'il manquait des volumes de capture de la base de données de la MRD. La synthèse de toutes les données disponibles a entraîné une proposition de nouvelle capture nominale totale pour les flottilles ghanéennes qui a dépassé la Tâche I actuelle de l'ICCAT d'environ 20 %. Dans un deuxième temps, le total des captures a été distribué dans le temps (mois) et dans l'espace (carrés de 5° x 5°) sur la base de quelques postulats découlant des informations disponibles. Enfin, des échantillons de taille disponibles de la pêcherie de senneurs européens sur les dispositifs de concentration de poissons ont été utilisés pour estimer la composition par espèce et par taille des prises sur la base d'une stratification a posteriori de l'échantillonnage de l'UE. Les estimations de la structure des tailles de la capture du listao ont été mises à disposition pour l'évaluation des stocks de 2014.

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RESUMEN

Se utilizó la información disponible procedente de diferentes fuentes para estimar la Tarea I y la Tarea II de los cañeros y cerqueros atuneros de Ghana durante 2006-2012. En primer lugar, los datos de captura y desembarque recopilados y gestionados por el Departamento de Investigación de Pesquerías Marinas (MFRD) de Ghana se describieron y compararon con las cantidades de túnidos desembarcados en Tema para su transformación en la Pioneer Food Cannery (PFC) Ltd. Se descubrió que algunos desembarques de unos pocos buques ghaneses eran inferiores de lo que se había vendido a la enlatadora, lo que resulta en una subestimación anual de aproximadamente 2.000-4.000 t durante 2009-2012. La información recopilada sobre los desembarques de túnidos destinados al mercado local de Abiyán puso de relieve también que parte de la captura faltaba en la base de datos del MRD. La síntesis de todos los datos disponibles tuvo como resultado una propuesta de nueva captura nominal total para las flotas ghanesas que superaba la actual Tarea I de ICCAT en aproximadamente un 20%. En un segundo paso, la captura total se distribuyó en el tiempo (mes) y el espacio (cuadrículas de 5º por 5º) basándose en algunos supuestos procedentes de la información disponible. Por último, las muestras de talla disponibles de la pesquería de cerco europea sobre dispositivos de concentración de peces se utilizaron para estimar la composición por especies y talla de la captura basándose en una postestratificación del diseño del muestreo de la UE. Las estimaciones de la estructura de tallas de la captura de listado se pusieron a disposición de la evaluación de stock de 2014.

KEYWORDS

Baitboat, Purse seining, FAD, Bigeye, Skipjack, Yellowfin

1. Introduction

The estimation of the total catch (Task I) and monthly spatially-aggregated catch (Task II) for the Ghana baitboat (BB) and purse seine (PS) tuna fisheries over the last years has been made difficult due to the general lack of information on fishing activities available to MFRD, with some segments of the fleet poorly covered by the monitoring system. Recently, the data collection has well improved, which resulted in the proposal of modifying the Task I for some years relative to the ICCAT database (Chassot *et al.*, 2013a). Information available for 2012 also gave insights into the total spatial distribution of the whole fishery. Based on the synthesis of available data, Chassot *et al.* (2013a) proposed a methodology to process the Ghanaian PS and BB data. The processing relies on the size-frequency samples collected aboard European PS during 2006-2012 and a spatio-temporal stratification based on year and 3 areas: the Cap Lopez area, the coasts of Ivory Coast and Ghana, and offshore areas (Fonteneau *et al.*, 2013).

Here, we use new information collected from a tuna processing cannery based in Tema (Ghana) and provided to the ICCAT Secretariat through the International Seafood Sustainability Foundation (ISSF) as well as estimates of landings on the local market of Abidjan and observations of transhipments-at-port between PS and reefers to update the total catches of Ghanaian tuna fisheries. We focus in the present paper on the period 2006-2012 as the Ghanaian fisheries data for 2013 are currently not available. The objectives of the study are to: (i) assess the consistency between data collected from logbooks and sale records and available from the processing cannery, (ii) update the total catch of the Ghanaian fleet according to all sources of information currently available, and (iii) propose a revised Task I and II for 2006-2012 based on size-samples collected through the European Data Collection Framework.

2. Materials

2.1 Ghana AVDTH database for 2006-2012

The Ghanaian AVDTH database includes all logbooks, sale records by commercial category (i.e. species and weight category), and size-frequency samples collected by MFRD during 2006-2012, with few data available for 2007. The vessel referential (Table BATEAU) is common with the IRD/IEO/CRO/CRODT (Chassot *et al.*, 2013b). Overall, the database includes a total of 1,199 fishing trips operated by 22 distinct BB and 18 PS during 2006-2012 (**Tables A1-A2**). The landings include both tuna unloaded for being processed at the canneries and quantities of tuna destined to the local market of Tema ("*faux-poisson*"). A Spanish PS flying the Ghana flag during 2006-2008 was not included in the present analysis as it was already included in the associated flags of the European purse seine fishing fleet (Delgado de Molina *et al.*, 2013).

2.2 Cannery data

Data obtained from the Pioneer Food Cannery (PFC) Ltd. based in Tema, Ghana, were provided to the ICCAT under confidentiality rules. The dataset represents the tuna sold to the cannery by a total of 55 vessels (fish unloaded or shipped in containers) during 2009-2013. Information includes the vessel name, date of entry of the fish to the cannery, period of fishing for some of the records, and quantities of tuna by commercial category (kg) purchased by PFC. The dataset includes information for 15 BB and 11 PS flying the Ghana flag.

2.3 Faux-poisson landings in Abidjan

Landings of non-target species by tuna fishing vessels and cargo ships to the local market of Abidjan (Côte d'Ivoire) have been monitored by IRD-CRO-IEO since the early 1980s (Chavance *et al.*, 2014). "*Faux-poisson*" estimates are based on the number of transport units observed and the mean capacity weight associated with each unit (Chavance *et al.*, 2011). Landings of "*faux-poisson*" from Ghanaian cargo ships in Abidjan were not considered here as the contents of the cargos could originate from Ghanaian fishing vessels that transhipped the tuna in Tema. A total of 30 fishing trips of Ghanaian vessels that unloaded in Abidjan during 2008-2010 were recorded in the MFRD database while estimates of "faux-poisson" landings made by Ghanaian BB and PS during 2006-2012 were available for 49 unloading operations. Seven trips were found common in both databases. The landings of "faux-poisson" in Abidjan were not double-counted as no information on landings destined to the local market was available in the MFRD database.

2.4 PANOFI monthly landings

In addition to the landings recorded on a trip basis in the MFRD database for the PANOFI purse seiners, a complementary file providing the monthly landings for the PANOFI fleet (P-fleet) during 2003-2010 was available through the PANOFI Ltd. Company. The two datasets gave similar total monthly landings for 2008 and January-October. 2010 while information differed for 2009 and was sparse and lacking in 2006-2007 in the MFRD database. Although less comprehensive, the MFRD database included information on landings destined to the local market for the PANOFI vessels that was not included in the monthly landing data file.

2.5 Monitoring of PANOFI transhipments

Information on transhipments of tuna between PANOFI purse seiners and the cargos VOLTA GLORY and VOLTA VICTORY was collected through the ICCAT regional observer program for transhipment 2012/2013 and is available for the year 2012 (ICCAT Secretariat, 2013). The dataset gives information on the fishing vessel, carrier, date of transhipment and the species composition of the quantities transhipped.

2.6 Size samples

Size samples collected from Ghanaian PS and BB during 2006-2012 in Tema (Ghana) could not be used in the present study due to a bias in the sampling methodology (Damiano *et al.*, 2013a, 2013b). Only five samples collected from FAD-fishing by the IRD-IEO-CRO team during 2012-2013 aboard two Ghanaian PS unloading in Abidjan were available. The samples were conducted following the current EU sampling protocol, i.e. a total 500 fishes are randomly selected in two rounds and counted/measured. The species composition is then estimated from the sample in number through species-specific length-weight relationships (Anon., 2010).

Additional information on the species composition of the Ghanaian catch was provided through samples collected from European purse seiners during 2006-2012, assuming that the composition of the catch only depends on the fishing mode (i.e. log-associated or free-swimming school) and spatio-temporal strata. Here, we considered that the total catch of both Ghanaian BB and PS is made on fish-aggregating devices (FADs) although information available from BB logbooks indicates that a component of their catch comes from sets made on free-swimming schools (Chassot *et al.*, 2013a). It is however currently not possible to identify the origin of the catch for BB which can conduct collaborative operations with PS and share some of the catch. By contrast, most of the Ghanaian PS catch was made on FAD-associated schools during 2006-2012. Overall, a total of 4,696 PS samples collected from European purse seiners during 2006-2012 were used to estimate the species composition of the Ghanaian catch.

3. Methods

Since no information is currently available on discards at-sea for the Ghanaian tuna fishery, the term landings refers to the information collected from sales records and at the cannery while catches refer to the information derived from the logbooks.

First, quantities of tuna purchased by PFC for processing were compared on an annual basis with the total catch and landings recorded by MFRD for the Ghanaian BB and PS. The year of processing (date of unloading at the cannery by the vessel or reefer) was used because the year of fishing was not available for all records in the PFC dataset. The years of catch (fishing operation) and landing (unloading at port) were used for the total catch and landings, respectively. This might result in some small discrepancy between the quantities of interest. In a second step, the "*faux-poisson*" database was used to estimate the quantities of tuna not recorded in the MFRD database and sold to the local market of Abidjan. In a third step, annual estimates of landings for the P-fleet were derived from the monthly landings by considering the maximum value available between the 2 data sources. Information available from observations of transhipments in 2013 was used to check the consistency of the data available for 2010-2012 when there were 6 active PS. Information available from the different data sources was then used to propose a revised total Task I for the Ghanaian BB and PS.

Second, the species composition derived from the information available from catches and landings recorded in the MFRD database was compared with the composition of the tuna unloaded at PFC. A total of 17 different commercial categories were recorded in the MFRD database. For simplification purpose, aggregated commercial categories were considered, i.e. small bigeye (BET <10kg), large bigeye (BET >10kg), skipjack (SKJ), small yellowfin (YFT <10kg), large yellowfin (YFT >10kg). The category MIX indicates a mixture of target species while the category OTH indicates other species such as frigate tuna (*Auxis thazard*) and little tunny (*Euthynnus alleteratus*). The proportion of landings sold to PFC for processing greatly varied between vessels and years. To reduce potential bias due to the selection of commercial categories by the cannery, we selected 6 PS which sold the large majority of their catch to PFC during 2009-2012 (i.e. >85% of their landings as recorded in the MFRD database). The species composition of the tuna caught by these purse seiners was computed from the two data sources, i.e. the landings recorded in the MFRD database and the PFC data. In addition, the samples collected aboard Ghanaian PS in 2012-2013 in Abidjan were used to appreciate the species composition of the catch based on scientific sampling. Finally, the results were compared with the estimates of species composition obtained from 2,688 samples made on the European PS catch on FADs during 2009-2012.

Third, following the methodology described in Chassot *et al*. (2013a), the Tasks I and II were computed following 3 steps that followed the estimation of the total nominal catch: (i) distribution among months, (ii) distribution in space and (iii) distribution between species and size classes. First, the total nominal catch (see **Table 4**) was distributed across months based on the logbook data available during 2006-2012 and comparison of the monthly seasonality of catch between the A-fleet and P-fleet (Chassot *et al*. 2013a). Second, the spatial distribution (5° by 5° resolution) of the catch was computed on a quarterly basis for each fleet, i.e. the BB, the A-Fleet, and the P-Fleet (Chassot *et al*. 2013a). In absence of information on the spatial distribution of the catch in 2007 for the BB and A-Fleet, the distribution observed in 2006 was used. For the P-Fleet, the spatial distribution observed in 2012 was used for all the period 2006-2011. Finally, the species and size composition estimated from the European size-samples collected from FAD-fishing and based on a yearly basis and 3-area stratification was assigned to each square-month (Chassot *et al*. 2003a).

4. Results

4.1 Improvement in data collection

Information available on landings and catches recorded in the MFRD database was not consistent for most of the Ghanaian baitboats and purse seiners. The scatterplot between annual catch and landings showed a strong departure from the 1:1 line, with some purse seiners described by no information on catch available in the logbooks and only information on landings (**Figure 1**). The discrepancy between catch and landings strongly decreased in 2012. The root mean square error (RMSE) computed between catch and landings decreased from an average of 1313 t during 2006-2011 to 485 t in 2012.

4.2 Additional catches

Data collected from the cannery showed some underestimation of the landings for some Ghanaian vessels. A few vessels were found to have sold higher quantities of tuna to PFC than recorded in the MFRD database (**Figure 2**). The annual quantities unloaded for processing at PFC exceeded the maximum values landed or caught for 2 baitboats, with the ratios between sales and the maximum between catch and landings being equal to 1.1 and 2.5. Four purse seiners were also found to have records of catch and landings lower than that recorded in the cannery dataset, with 1 purse seiner having substantial differences (i.e. under-reporting) between total catches and sales in 2009, 2010, and 2011 (**Figure 2**). Overall, the difference between PFC data and the MFRD records reached more than 12,000 t during 2009-2012, the unloading to the cannery exceeding MFRD catch and landings by about 4,400 t in 2010 and less than 2,000 t in 2012 (**Table 1**).

4.3 Local market of Abidjan

Monitoring the "*faux-poisson*" in Abidjan enabled to identify some landings to the local market by Ghanaian vessels that were not accounted for in the MFRD database. The cumulated estimates of landings to the local market reached 191 t in 2008 and 909 t in 2009 for the 7 fishing trips identified in the MFRD database. In addition, some trips with unloading in Abidjan were not recorded in the MFRD database and therefore absent from the total landings. Overall, the total landings by Ghanaian vessels on the local market of Abidjan greatly varied according to gear and year and resulted in a total of more than 8,300 t during 2006-2012 (**Table 2**).

4.4 Catches of the P-fleet

The total catch derived from the logbooks available for the P-fleet during 2006-2011 was less than 5,500 t, and represented a very small part of the fleet landings. The total landings of the PANOFI vessels recorded in the MFRD database were smaller than given in the additional file covering the period 2006-2010. Considering the maximum monthly total value from the 2 data sources, the annual landings of the P-fleet were found to vary between a minimum of about 17,300 t in 2008 and a maximum of about 33,500 t during 2010-2011 (**Table 3**). Additional catches destined to the local markets of Tema and Abidjan were subsequently added to the landings to provide an overall estimate of annual catch for the P-fleet (**Table 3**).

Observations of transhipments from the PANOFI purse seiners to the cargo ships indicate a total quantity transhipped of about 27,000 t in 2013, consistent with the levels of landings estimated at about 30,000 t during 2010-2012, when the same number of PS were in activity.

All available information gathered on catches and landings for the Ghanaian PS and BB is summarised in **Tables 4 and 5**. In absence of good data available to MFRD in 2007, we proposed to use the total catch of the current ICCAT Task I. The total catch of the remaining Ghanaian PS (A-fleet) was computed as the difference between ICCAT Task I and the PANOFI PS landings (**Table 5**). Overall, our results indicate that the current total Task I of ICCAT could be underestimated by about 18% over 2006-2012. Data available suggest that the total catches for the Ghanaian BB could be underestimated in 2006 (+10%), 2011 (+57%) and 2012 (+11%). The high total catch of about 44,000 t in 2008 in the ICCAT database seems inconsistent with the levels of landings observed during 2008-2012 when no major change in the number of BB in operation occurred. For the PS, our results suggest that the current Task I could underestimate the catch by about 37%, with underestimation up to 90% in 2006 and 2008. Data available in 2012, which appear very consistent between logbooks (catches) and landings and cover well the P-fleet, confirm the typical underestimation of the total Task I by about 20%.

4.5 Species composition of the catch

Information on the species composition of the catch available in the MFRD database during 2009-2012 differed between logbooks and sale records. Except for 2009, sale records indicated more SKJ and less YFT in the landings than in the logbooks. For the BB fishery, SKJ predominated with 62-70% of the catch during 2009-2012 while YFT varied between 22% and 29% (**Figure 3a**). The percentage of bigeye declared in the catch was low, i.e. less than 4.5%. For the PS fishery, the percentage of SKJ in the catch varied between a minimum of 57% in 2010 and a maximum of 70% in 2012 (**Figure 3b**). The part of YFT was comprised between 20% and 27% and BET represented 5-8% of the catch declared in the logbooks.

Sale records indicated that large YFT (>10 kg) represented a small part of the Ghanaian BB and PS landings which were predominated by SKJ and small YFT (<10 kg). The species composition of the landings recorded in the MFRD database showed that the Ghanaian BB landings were composed on average of 60% of SKJ during 2009-2012, with an increase from 53% in 2009 to 75% in 2012 (**Figure 4a**). Meanwhile, the percentage of YFT in the landings of BB decreased from 27% in 2009 to about 15% in 2012. Large YFT (>10 kg) represented between 2% and 4.4% of the catch during 2009-2012 while the percentage of small YFT varied between 11% and 25%. BET (mostly tunas <10kg) represented 16% of the BB landings declared in 2009 and their contribution (as recorded in the landings) decreased to about 1% in 2011-2012 (**Figure 4a**). For the Ghanaian PS, SKJ represented more than 70% of the landings during 2009-2012 while the percentage of the juveniles of YFT (<10kg) varied between 7% and 20% over the period (**Figure 4b**). BET contribution to the landings decreased from 16.5% in 2009 to 5% in 2012. Large YFT and BET only represented between 4-6% and 2-3% of the landings during 2009-2012. The species composition of the landings of the selected purse seiners which sold most of their catch to PFC was very similar to the one of the whole Ghanaian PS fleet, i.e. predominated by SKJ (73%) and small YFT (12%) during 2009-2012. Large YFT represented about 6.4% of the catch of these PS over the period vs. 3.5% and 4.9% for the BB and PS fleets, respectively. The species composition of the selected PS derived from the MFRD database was very similar to the one available from the PFC dataset: the average percentage of SKJ and small YFT was respectively 75% and 13% during 2009-2012 while large YFT and BET represented each about 6% of the catch (**Figure 5**).

The 5 size samples collected in 2012-2013 from Ghanaian PS unloading in Abidjan were very consistent with the data collected from landings and processed at PFC. The samples showed a species composition characterized by a majority of skipjack that represented between 57% and 84% of the biomass caught on FAD-associated schools. Small YFT (<10kg) comprised between 6% and 24% of the catch while large YFT and large BET (>10kg) were poorly represented in the catch, i.e. always less than 9%.

The more than 2,500 samples collected aboard European purse seiners during 2009-2012 from FAD-associated fishing sets showed a species composition predominated by SKJ that increased from 63% in 2009 to 74% in 2012. YFT represented about 14.6% (SD = 3%) of the catch, with large YFT (>10kg) contributing to 35-45% of YFT catch. BET that was mostly dominated by small tunas (>66% of the biomass caught) contributed to 12-16% of the catch.

4.6 Size structure of the SKJ in the catch

Size samples available from the European samples showed a different size distribution for skipjack between the 3 areas considered in the processing. The size range observed in the coastal areas of Côte d'Ivoire and Ghana was restricted to 32-60 cm fork length (F_L) with a median size of 44 cm (**Figure 6a**). The area of Cape Lopez was characterized by larger SKJ and a median size of 47 cm FL (**Figure 6b**). Finally, offshore areas were described by a median size of 43 cm and characterized by small-sized SKJ (**Figure 6c**).

4.7 Processed Task I

The task I of the Ghanaian tuna fisheries is given in **Table 6**. The data processing resulted in an overall increase in the percentage of BET in the catch for each fleet as compared to that declared in the logbooks and the landings. The BB were characterized by an annual average of 11% of BET while it represented less than 2.4% on average in the logbook declarations during 2006-2012. Similarly, BET was estimated to contribute to about 13% of the catch of the PS while its percentage of the catch varied between 2% and 8% in the logbooks. SKJ contributed to about 2/3 of the catch (average of 67% over 2006-2012) for both BB and PS. Finally, YFT represented an annual average of 17% and 16% of the catch for the BB and PS, respectively.

5. Discussion

5.1 Total Task I

Our results are conservative as we made the assumption that the fishing trips recorded in the MRFD database cover all the trips of the fishery, i.e. our estimates must be seen as a lower bound of the Ghanaian total task I. Total landings might however be underestimated as suggested by the PFC data which showed that some trips of BB and PS were not included in the MFRD database. The monitoring of "faux-poisson" landings in Abidjan also showed that some unloading operations taking place outside Ghana were not recorded until recently. IRD will now provide MFRD with the information on "faux-poisson" collected in Abidjan in order to complement the fishing trips and improve the monitoring of the total landings of the fishery. It is also noteworthy that the total catch estimated does not include any information on discards-at-sea which are expected to be small with regards to the local markets of Tema and Abidjan. Despite the importance of the "faux-poisson" market in Abidjan, tuna discards in the European purse seine fisheries were found to be higher than in the Indian Ocean, i.e. about 70t/1000t of tuna landed during 2003-2007 (Amandè *et al*., 2010). Information on bycatch and discards might be collected through the current Ghana fisheries observer program.

5.2 Species composition of the catch

The species and size composition of the Ghanaian tuna fisheries is considered similar between BB and PS because it is currently impossible to separate the catch between gears due to collaboration at-sea. Here, we assumed that all the catches of both fishing gears were made on FAD-associated sets. Information available in the logbooks however indicates that the BB make a substantial part of their fishing sets on free-swimming schools while Ghanaian PS mostly focus on schools associated with DFADs (Chassot *et al.* 2013a). In addition, the increasing use of artificial drifting fish aggregating devices (DFADs) in the Ghanaian BB fishery could result in changes in the species composition of catch over time that are not captured by the size-samples collected from European purse seiners. Information on the collaboration between BB and PS has now been collected and entered into the MFRD database but it remains difficult to reallocate a posteriori the catch between gears. The poor quality of well plans available for Ghanaian vessels, partly due to shifts of tuna between wells during cruises, currently prevents a clear separation between BB and PS catch.

References

Amandè, M.J., Ariz, J., Chassot, E., Delgado de Molina, A., Gaertner, D., Murua, H., Pianet, R., Ruiz, J., Chavance, P., 2010. Bycatch of the European purse seine tuna fishery in the Atlantic Ocean for the 2003–2007 period. Aquat. Living Resour. 23, 353–362. doi:10.1051/alr/2011003.

Anon. 2010. Report of the international working group on tuna purse seine and baitboat catch species composition derived from observer and port sampler data, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, Madrid, Spain, pp. 486–511.

Chassot, E., Ayivi, S., Floch, L., Dewals, P., Damiano, A., Cauquil, P., Dubroca, L., Bannerman, P., 2013a. Analysis of Ghanaian industrial tuna fisheries data: Towards Tasks 1 and 2 for 2006-2012, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, p. 21p.

Chassot, E., Ayivi, S., Floch, L., Dubroca, L., Cauquil, P., Damiano, A., 2013b. Strengthening Ghanaian industrial purse seine fishery monitoring in the Gulf of Guinea Sète workshop, May 27-31st 2013, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, p. 13.

Chassot, E., Ayivi, S., Floch, L., Dubroca, L., Cauquil, P., Damiano, A., 2013c. Strengthening Ghanaian industrial purse seine fishery monitoring in the Gulf of Guinea Sète workshop, May 27-31st 2013, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales. ICCAT, p. 13.

Chavance, P., Amon Kothias, J.B., Dewals, P., Pianet, R., Amandè, M.J., Delgado de Molina, A., Djoh, A., 2011. Statistics on tuna surface fishery's bycatch landed in Abidjan, Côte d'Ivoire, for the 1982-2009 period, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, Madrid, Spain, pp. 2104–2112.

Chavance, P., Dewals, P., Amandè M. J., Delgado de Molina, A., Damiano, A., Tamegnon, A., 2014. Tuna fisheries catch landed in Abidjan (Côte d'Ivoire) and sold on local fish market for the period 1982-2013 (preliminary data), in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, Madrid, Spain, p. 9p.

Damiano, A., Rojo, A., Dubroca, L., Barrigah, S., Bannerman, P., Ayivi, S., 2013a. Report for the tuna sampling technical workshop held in Tema, 2012 November 4 to 16, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. p. 10.

Damiano, A., Rojo, V., Barrigah, S., 2013b. Report of the tuna sampling training course in Tema, July 16 to 20, 2012, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales, ICCAT Col. Vol. Sci. Pap. ICCAT, Madrid, Spain, pp. 2081–2086.

Delgado de Molina, A., Floch, L., Rojo, V., Damiano, A., Ariz, J., Chassot, E., N'Gom Sow, F., Chavance, P., Tamegnon, A., 2013. Statistics of the European and associated purse seine and baitboat fleets, in the Atlantic Ocean, in: Tropical Tunas = Thonidés Tropicaux = Tunidos Tropicales. ICCAT, Madrid, Spain, p. 12.

Fonteneau, A., Bannerman, P., Ayivi, S., Fonteneau, V., 2013. New TASK2 (catch & effort, catch at size) statistics estimated in 2013 for the Ghanaian fleet during the 1996-2005 period. ICCAT Col Vol Sci Pap SCRS/2013/022, 50.

ICCAT, 2013. Report on the implementation of the ICCAT Regional Observer Programme (ROP) for transhipment 2012/13 (No. PWG-402/2013), Report on ROP_transhipment. ICCAT, Madrid, Spain.

Table 1. Annual catch (t), landings (t), and quantities of tuna sold to the cannery PFC (t) during 2009-2012 for the subset of baitboats and purse seiners for which the record of unloading at PFC was larger than the maximum between catch and landings as recorded in the MFRD database.

Year	Gear	Catch	Landings	PFC	Diff.
2009	BB	663	702	754	-52
2010	BB	559	540	1388	-829
2009	PS	2956	2220	6862	-3873
2010	PS	4435	3828	7985	-3550
2011	PS	6813	7277	9321	-2044
2012	PS	2797	2408	4711	-1914

Table 2. Estimates of annual landings (t) to the local market of Abidjan (*Faux-Poisson*, FP) by Ghanaian vessels during 2006-2012.

Year	Gear	FP
2006	BB	221
2007	BB	286
2008	BB	67
2009	BB	1269
2010	BB	770
2012	BB	35
2007	PS	1136
2008	PS	568
2009	PS	2187
2010	PS	219
2011	PS	169
2012	PS	1399

Table 3. Estimates of annual landings (t) for the PANOFI fleet during 2006-2012 derived from (i) the total monthly landings available for the fleet and (ii) part of the landings available on a trip basis, and (iii) the monitoring of "*Faux-Poisson*" in Tema (FP_TEMA) and Abidjan (FP_ABJ).

Year	Landings	FP_TEMA	FP_ABJ	Total
2006	25964	11.9	0	25975.9
2007	20457.2	0	859	21316.2
2008	17285	376	444	18105
2009	19285.8	39	808	20132.8
2010	33603.3	450.5	219	34272.8
2011	33285.5	888.5	169	34343
2012	29975.6	1254.5	1331	32561.1

Table 4. Total nominal catch, landings, and estimates of "faux-poisson" in Tema (FP_TEMA) and Abidjan (FP_ABJ) by gear group. Total is based on the maximum between catches and landings. Proposal corresponds to the proposition of updating of the total ICCAT Task I. PFC indicates landings to the Pioneer Food Cannery that exceed catch recorded in the MFRD database.

Year	GearGrp	Catches	Landings	FP_TEMA	FP_ABJ	PFC	Total	Proposal
2006	BB	31062	28973	457	221		31740	31740
2007	BB	3139	0	0	286		3425	25502*
2008	BB	22330	25259	2818	67		28144	28144
2009	BB	27809	27284	1211	1269	91	30380	30380
2010	BB	22035	21733	1340	770	829	24974	24974
2011	BB	24926	16574	913	0	0	25839	25839
2012	BB	23938	22812	1314	35	0	25287	25287
2006	PS	13440	43299	161	0	0	43460	43460
2007	PS	4361	20457	0	1136	0	25954	42249*
2008	PS	18545	35513	1908	568	0	37989	37989
2009	PS	40977	50072	516	2187	3906	61428	61428
2010	PS	36778	61989	1094	219	3550	74299	74299
2011	PS	29390	54894	1061	169	2508	64652	64652
2012	PS	54052	53772	2489	1399	1914	62563	62563

* indicates that the proposal was derived from the current ICCAT task I in absence of other information

Table 5. Total nominal catch, landings, and estimates of "faux-poisson" in Tema (FP_TEMA) and Abidjan (FP_ABJ) for the Ghanaian purse seine fleet split into two components, the PANOFI vessels (P-Fleet) and other vessels (A-Fleet).

Year	GearGrp	Fleet	Catches	Landings	FP_TEMA	FP_ABJ	PFC	Total	Proposal
2006	PS	A-Fleet	12781	17335	149	0		17484	17484
2007	PS	A-Fleet	4361	0	0	277		4638	20933
2008	PS	A-Fleet	18040	18228	1532	124		19884	19884
2009	PS	A-Fleet	35533	30786	477	1379	3906	41295	41295
2010	PS	A-Fleet	35833	28386	643	0	3550	40026	40026
2011	PS	A-Fleet	27629	21608	172	0	2508	30309	30309
2012	PS	A-Fleet	26786	23796	1234	68	1914	30002	30002
2006	PS	P-Fleet	659	25964	12	0		25976	25976
2007	PS	P-Fleet	0	20457	0	859		21316	21316
2008	PS	P-Fleet	505	17285	376	444		18105	18105
2009	PS	P-Fleet	5444	19286	39	808	0	20133	20133
2010	PS	P-Fleet	945	33603	451	219	0	34273	34273
2011	PS	P-Fleet	1761	33286	889	169	0	34343	34343
2012	PS	P-Fleet	27266	29976	1255	1331	0	32561	32561

Table 6. Annual catch by gear, fleet, and species for the Ghanaian fisheries derived from the data processing.

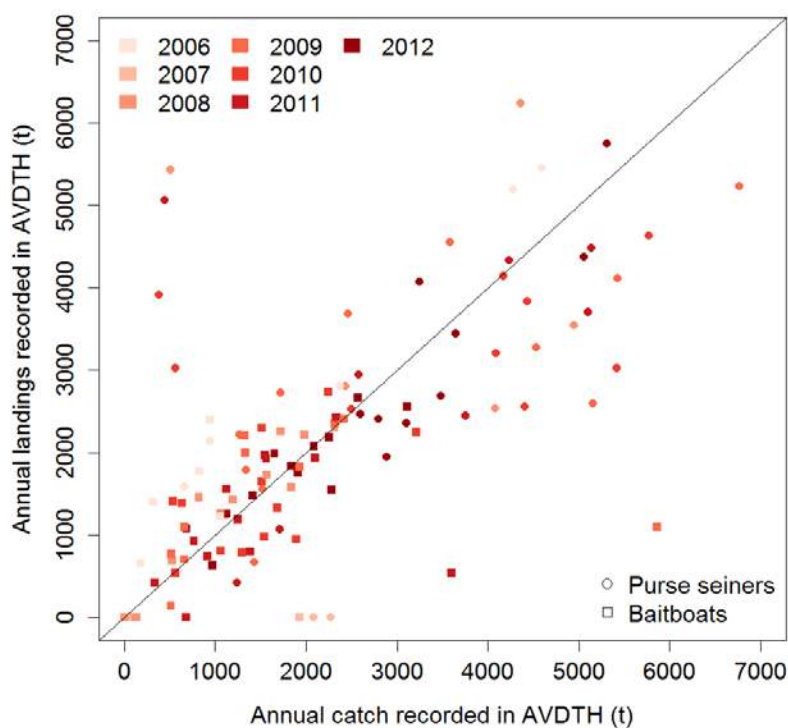| Fleet	YearC	GearGrp	YFT	SKJ	BET	ALB	LTA	FRI	Total
BB	2006	BB	6229	20591	3303	0	451	1167	31740
BB	2007	BB	4757	17195	2196	1	564	790	25503
BB	2008	BB	6463	17677	3069	4	312	618	28144
BB	2009	BB	6969	17851	4020	4	651	885	30379
BB	2010	BB	3866	16525	3153	5	401	1024	24974
BB	2011	BB	3067	18309	3385	0	245	833	25839
BB	2012	BB	2752	19182	2132	0	589	629	25285
A-Fleet	2006	PS	3100	11700	1922	0	158	603	17484
A-Fleet	2007	PS	3335	14474	2039	2	421	665	20935
A-Fleet	2008	PS	4201	12601	2383	3	236	460	19884
A-Fleet	2009	PS	8102	25524	5560	6	796	1308	41295
A-Fleet	2010	PS	6423	25468	6080	10	603	1442	40026
A-Fleet	2011	PS	3766	20257	5234	0	358	694	30309
A-Fleet	2012	PS	3187	22410	3152	0	390	860	29999
P-Fleet	2006	PS	4266	17820	2914	0	174	802	25976
P-Fleet	2007	PS	3023	14969	2296	2	350	679	21318
P-Fleet	2008	PS	3463	11513	2511	3	197	418	18105
P-Fleet	2009	PS	3166	12928	3198	4	245	593	20133
P-Fleet	2010	PS	5443	21332	5890	10	461	1138	34273
P-Fleet	2011	PS	4210	22816	6150	0	398	768	34343
P-Fleet	2012	PS	3408	24184	3690	0	295	980	32558

Figure 1. Comparison between total annual catch and landings as recorded in the MFRD database for Ghanaian purse seiners (circles) and baitboats (squares) during 2006-2012.
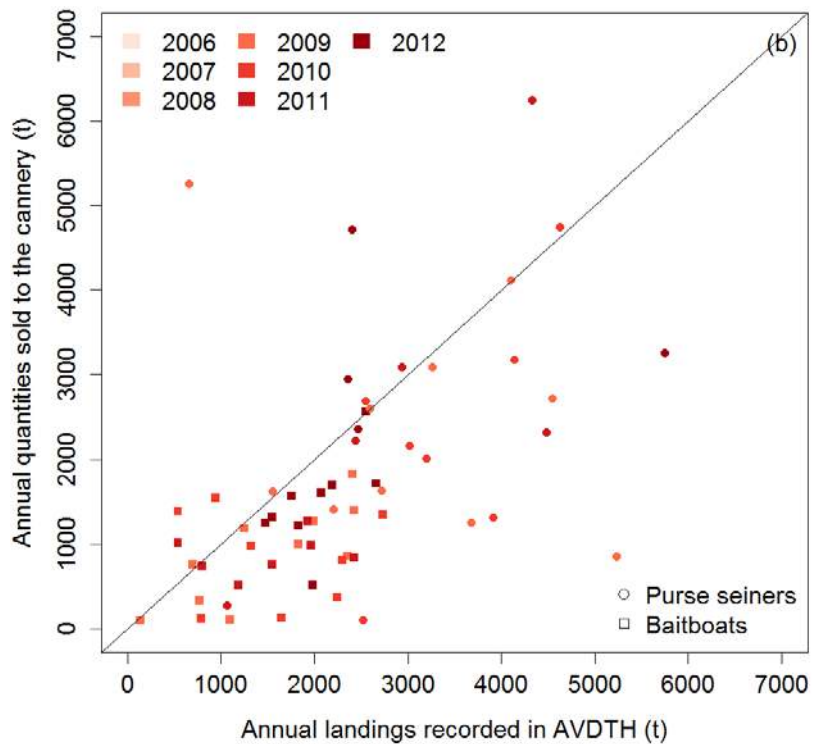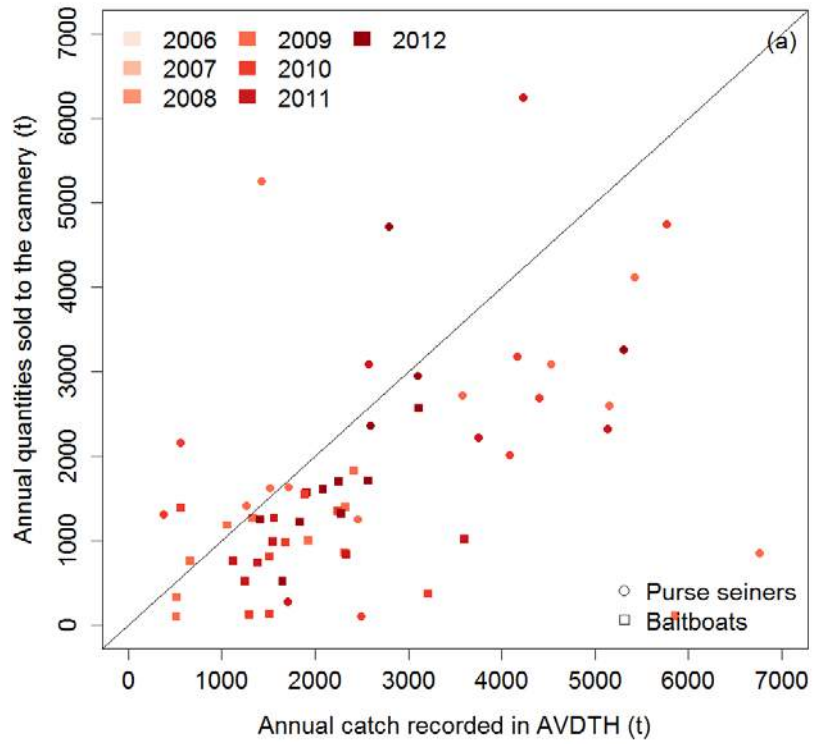
Figure 2. Comparison between (a) annual total catch and (b) annual total landings as recorded in the MFRD database and quantities unloaded for processing at the PFC cannery for Ghanaian purse seiners (circles) and baitboats (squares) during 2009-2012.
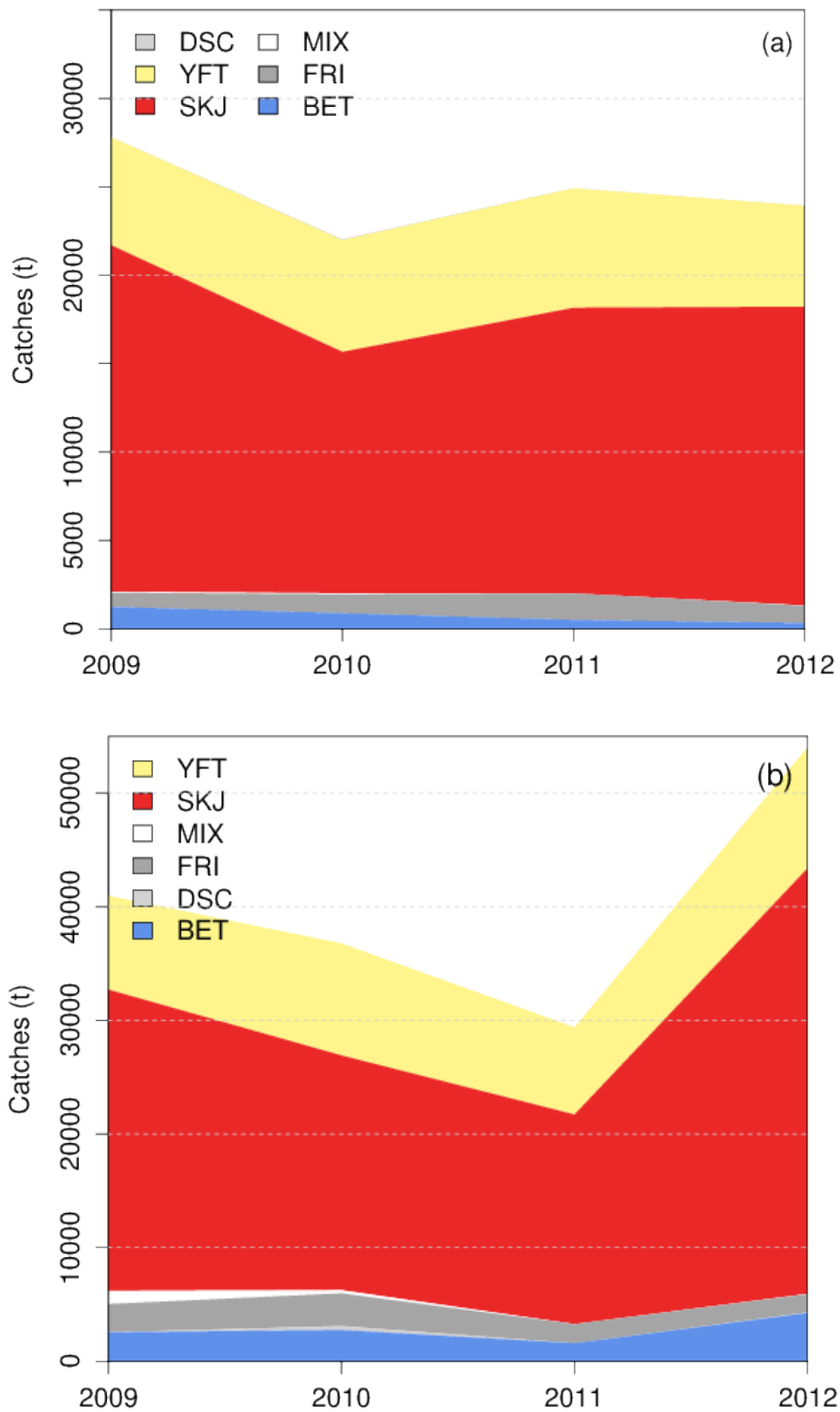
Figure 3. Cumulated catches by species as recorded in the MFRD database during 2009-2012 for Ghanaian (a) baitboats and (b) purse seiners. DCS = Discards; FRI = Frigate tuna; MIX = mixture of tunas.
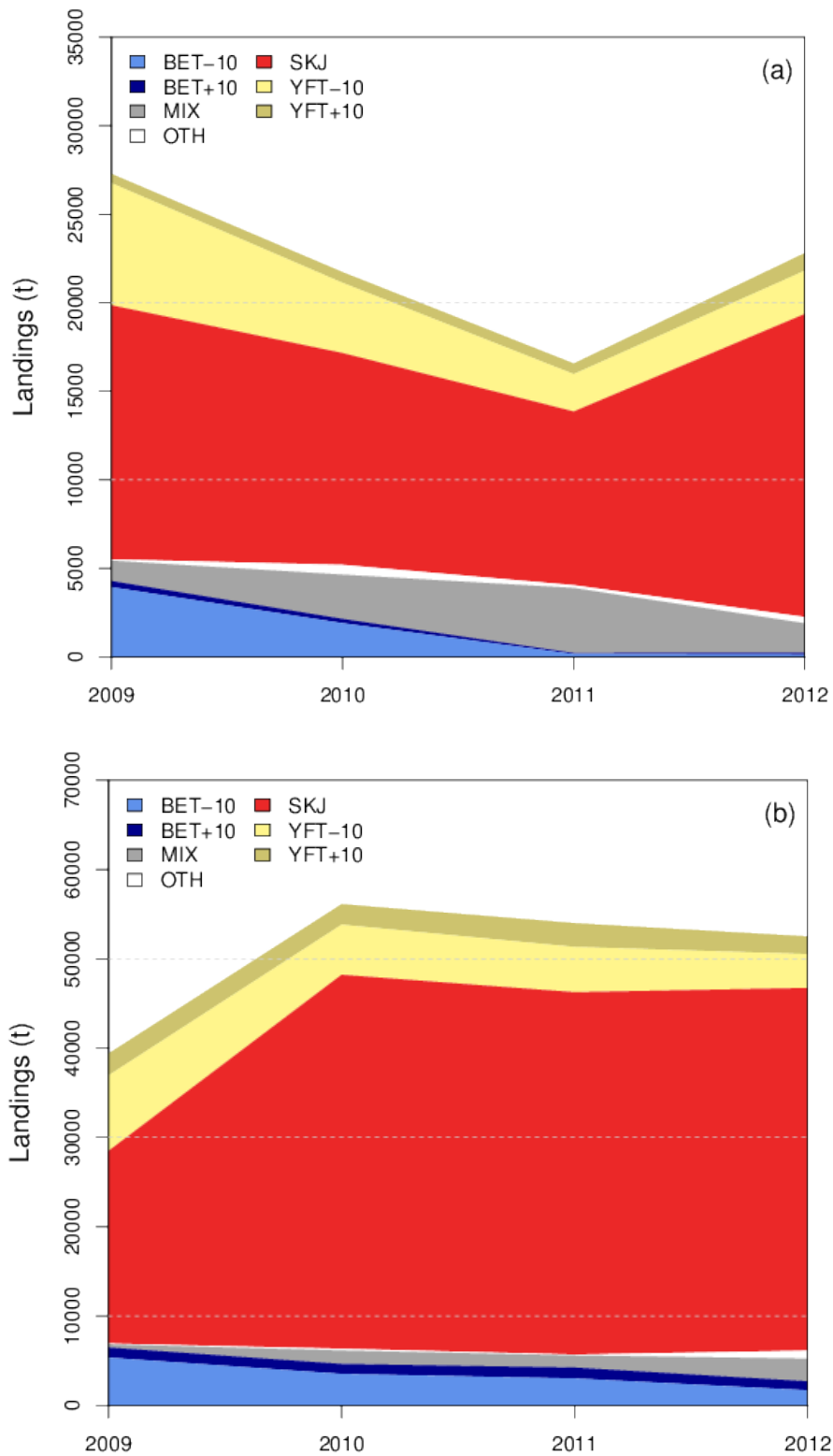
Figure 4. Cumulated landings by commercial category as recorded in the MFRD database during 2009-2012 for Ghanaian (a) baitboats and (b) purse seiners. Mix = Mixture of tuna species; OTH= non-target species.
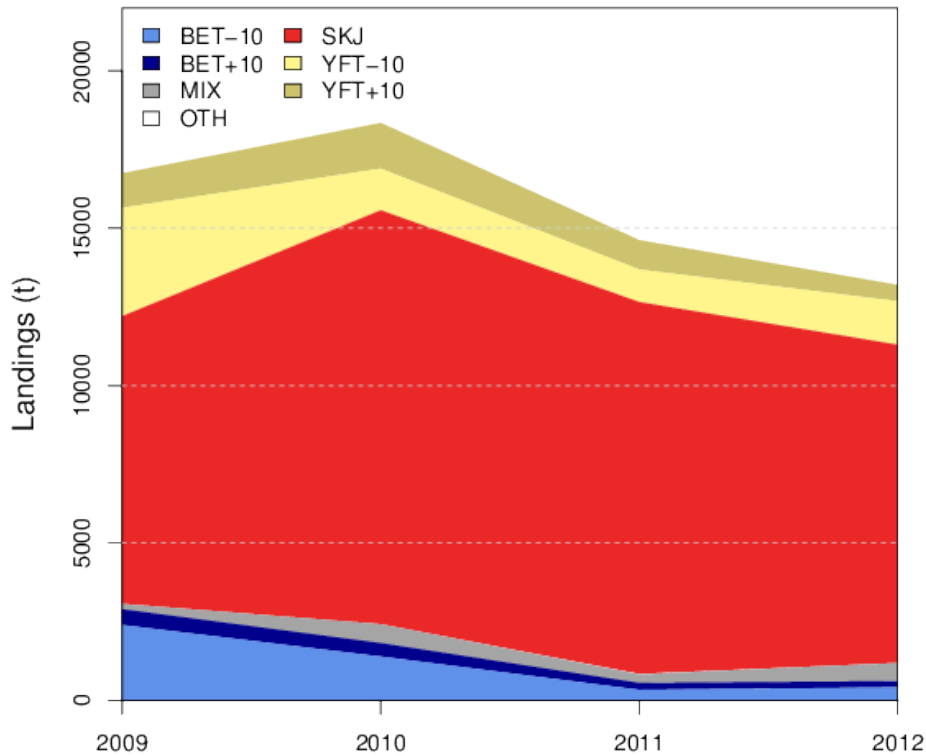
Figure 5. Cumulated landings by commercial category for the TTV purse seiners during 2009-2012 as recorded in the MFRD database. Mix = Mixture of tuna species; OTH= non-target species.
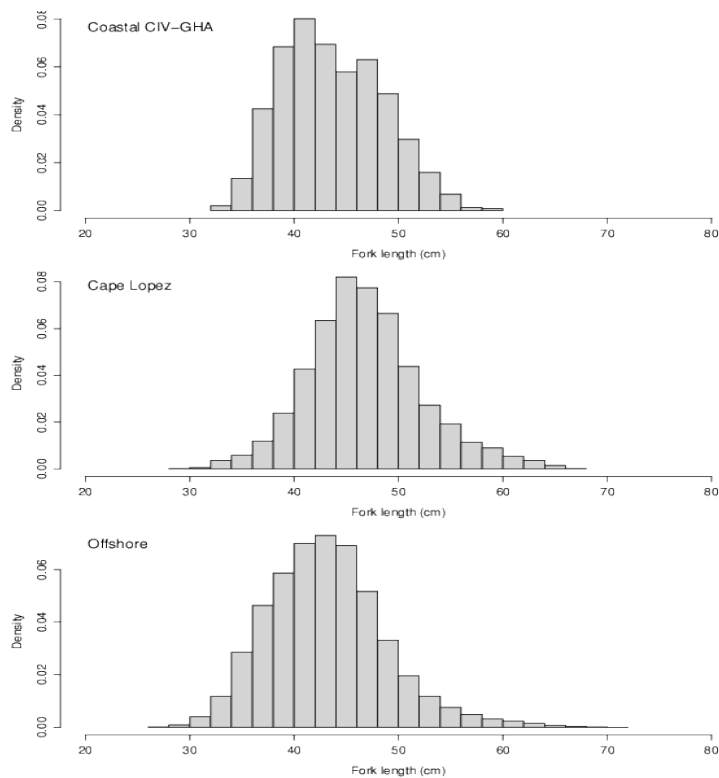

Figure 6. Frequency density histograms of size for skipjack caught by the European purse seiners during 2006-2012 for each area considered in the data processing: (top panel) Coastal Ivory Coast-Ghana, (medium panel) Cape Lopez and (bottom panel) Offshore areas. See Chassot *et al.* (2013a) for area definition.

Table A1. List of distinct vessels in the MFRD database during 2006-2012. minYear and maxYear indicate the minimum and maximum year for which some sale records are available, respectively.

Gear	Vessel name	minYear	maxYear
BB	AFKO 305	2006	2010
BB	AFKO 306	2006	2010
BB	AFKO 308	2006	2010
BB	AFKO FOODS 801	2006	2010
BB	AFKO FOODS 802	2006	2008
BB	AFKO FOODS 803	2006	2012
BB	GBESE 8	2006	2012
BB	GBESE 9	2006	2006
BB	GBESSE 11	2006	2012
BB	JITO 5	2006	2012
BB	LAUREL	2008	2012
BB	MAKOKOS	2006	2011
BB	MARINE 703	2006	2012
BB	MARINE 707	2006	2012
BB	MARINE 711	2006	2012
BB	RICO SIETE	2009	2012
BB	RICO UNO	2006	2012
BB	SEAPLUS 87	2006	2012
BB	SEAPLUS 89	2006	2012
BB	TRUST 77	2006	2012
BB	TRUST 79	2006	2012
BB	VICTORY	2006	2011
PS	AFKO 805	2006	2012
PS	AGNES 1	2006	2012
PS	AVEL HUEL	2006	2006
PS	CAP DES PALMES	2009	2012
PS	CAP LOPEZ	2009	2012
PS	CAP SAINT PAUL	2009	2012
PS	DRAGO	2006	2012
PS	ILE DE KERBIHAN	2006	2012
PS	LAURENT	2006	2012
PS	OWUM OPE SIKA	2010	2012
PS	PANOFI DISCOVERER	2010	2012
PS	PANOFI FORERUNNER	2010	2012
PS	PANOFI FRONTIER	2006	2012
PS	PANOFI MASTER	2006	2012
PS	PANOFI PATHFINDER	2010	2012
PS	PANOFI VOLUNTEER	2006	2012
PS	YOUNG BOK	2009	2012

Table A2. Annual number of fishing trips (Ntrips) by Ghanaian baitboats and purse seiners during 2006-2012 and landing port as recorded in the MFRD database.

Year	Port	No. Trips
2006	TEMA	148
2007	TEMA	20
2008	ABIDJAN	21
2008	LAS PALMAS	1
2008	TEMA	165
2009	ABIDJAN	6
2009	TEMA	192
2009	WALVIS BAY	1
2010	ABIDJAN	9
2010	TEMA	207
2011	TEMA	199
2012	TEMA	220
2012	WALVIS BAY	10